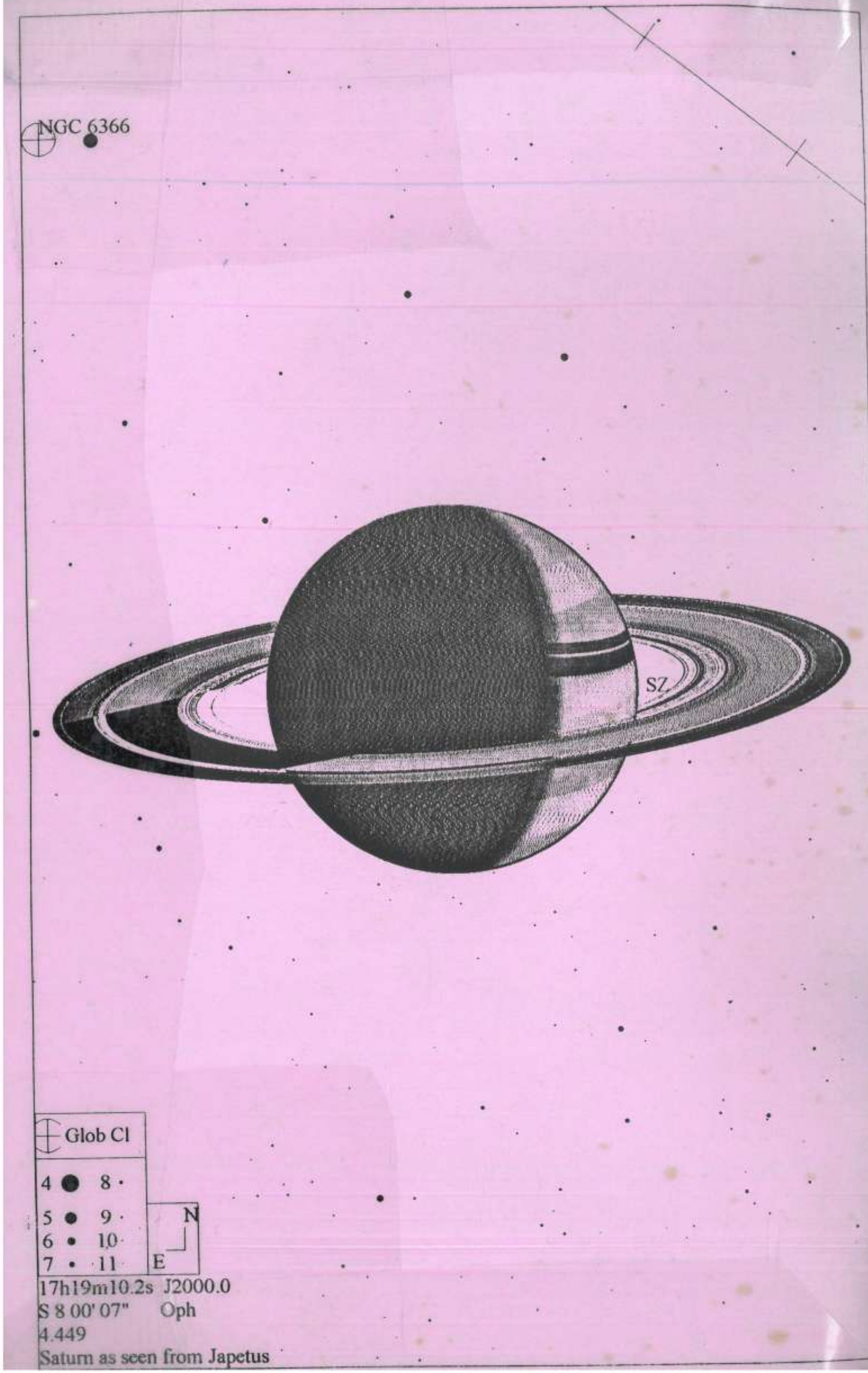
# GUIDE

Version 7.0

Project Pluto

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**Appendices:**

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## 1: HOW TO INSTALL GUIDE

Installation of Guide is simple. Installation software is available for both DOS and Windows. The Windows setup will be described first.

Put the Guide CD-ROM into the CD-ROM drive. In Windows 3.1, you click on File... Run; in Windows 95 and 98, Start... Run. Then enter

e:setup

(Replace 'e' with the drive letter of your CD-ROM drive.)

The installer will ask for the name of the directory on your hard drive where you want the Guide files to go. You can specify a directory that doesn't exist yet; it will make it for you. You'll also see three check-boxes: for DOS, Windows 3.1 (16-bit) software, and/or Windows 95/98/NT (32-bit) software. Most users will just use the default, which is to load only the Windows 95/98/NT software. But there are still a few Win3.1 and DOS users out there, and software is made available to them on the same CD-ROM. The two Windows versions are essentially identical, except that the 32-bit software is considerably faster on certain tasks.

Check one, two, or three boxes, according to which versions you want to use. (Some users like having both the DOS and one Windows version available.)



The installer will then copy over about two dozen files into your directory, giving a running account of how much progress it is making. When it finishes, you'll get one, two, or three icons (depending on how many check-boxes you selected) added to your screen.

DOS users will also insert the CD, but will then run INSTALL from the CD. This process is somewhat simpler, since you don't have to choose which versions are loaded. You just have to specify the directory to be used, just as with the Windows SETUP installer.

If you already have versions 1.0 through 6.0 of Guide installed on your hard drive, it would be best to install version 7.0 in a different directory. When you are sure that version 7.0 is properly installed and working to your satisfaction, you can then remove the old version.

You may notice that the CD also contains software called DSETUP.EXE and DINSTALL.EXE. These are German-language versions of SETUP and INSTALL, respectively, and should be ignored by non-German speakers.

## 2: STARTING GUIDE

If you intend to use only the Windows version of Guide, starting the program is quite simple; just double-click on its icon. In Win95 or Win98, one can click on "Start... Programs... Guide". Windows users can therefore ignore this chapter. DOS users have a slightly harder time of it; they must change to the Guide directory, and run the program DOSGUIDE.

In what follows, the program will almost always be referred to as Guide. It's true that the DOS software has the name DOSGUIDE.EXE, the 16-bit Windows software GUIDE6.EXE, and the 32-bit software GUIDE7.EXE. But from the viewpoint of the user, these programs operate almost identically (and the differences will be pointed out in the text.)

The DOS version of Guide can be used either with or without a mouse. If you do have a mouse, you must run MOUSE before starting Guide. (A few mice require a program with the same purpose but a different name. Guide should accept these substitutes.) You can either re-run the MOUSE routine each time you intend to use Guide, or put MOUSE in your AUTOEXEC batch file. (MOUSE may already be there.)

If you don't have a mouse, you will be able to use the cursor keys to move the "mouse cursor", the Ins key to "click the left mouse button", and the Del key to "click the right mouse button."

Now change to the directory you specified in the INSTALL step, and type DOSGUIDE, and hit the Enter key. After a few

seconds, the screen should clear and show a view of the Big Dipper, with a legend at the lower left corner.

### 2a: Using Super-VGA modes (DOS)

The Windows version of Guide will simply use the current Windows screen resolution; you don't need to adjust Guide at all. In the DOS version, you need to select your video mode; this is done in the Settings menu.

By default, the DOS Guide starts up in the "standard VGA" mode: 16 colors, 640x480. The advantage of this mode is that it is implemented in exactly the same way ("standard") on ALL VGA cards, so you can be quite sure that it will work. But you may want more resolution, or the use of 256 colors in order to show stars colored by their spectral types and planets with proper colors. To do this, go into the Settings menu and click on "Video mode". Guide will list the six video modes it understands, ranging from Standard VGA up to 1024x768, 256 colors.

It will not be immensely surprising if some SVGA modes do not work, usually resulting in a message such as "Can't set that video mode." If this happens, you can try two solutions.

First, if you have a VESA (Video Electronics Standards Association) driver, load it. DOSGUIDE can work with almost any video card, but definitely should work with VESA-compatible cards.

Second, try a different mode. In some cases, you'll find that (for example) a 16-color mode is not supported, but a 256-color mode is; or that a low-resolution mode fails, while another mode works.

## 3: GETTING HELP

Guide has an extensive help system, with information on menu items and a glossary of some astronomical terms. To get help on a particular subject, click on the "Help" option in the Main Menu and select "Glossary".

The Help system is a "hypertext" system; you can click on any term shown in blue to get the definition for that term. Menu options are available to print the help information, save it to a file, go back to the glossary, go back to the previous item, and to leave the help system.

You can also reach reach the Glossary at any time in Guide by hitting the comma (,) key.

Also available in the help system is a list of hotkeys. You can reach it at any point by hitting the question mark (?) key.



## 4: WHAT GUIDE IS SHOWING YOU

Let's start out by describing what you are seeing in the chart area. Guide has the ability to show any part of the sky at a wide range of detail. Right now, it's showing you a large piece of the sky (the Big Dipper and some surrounding sky) at about the detail you might see with your unaided eye. If all that was shown were stars, however, you might find it a little difficult to navigate your way around the sky, which is why there are some other markings visible. (You can turn any of the markings on or off according to personal taste. This is done inside the Display menu, described on page 20, and inside the Overlays menu, described on page 41.)

First, you'll notice that the stars are of different sizes, corresponding to how bright they appear to be from Earth. You will also notice that green lines connect some stars. In particular, the stars of the Big Dipper are connected. The lines join together the major stars within a constellation and are called constellation lines. They have no real astronomical significance, but they can serve as an aid to remembering where stars and constellations are.

Also, the constellation lines are separated from one another by orange lines. These are constellation boundaries. The entire sky was officially subdivided into 88 constellations in 1930. The borders are like those of the Western United States; they run the equivalent of east-west and north-south. They are shown to provide a further frame of reference.

Each constellation also has a three-letter abbreviated label shown in light blue somewhere within the constellation bounds. That for the Big Dipper is "UMa", meaning "Ursa Major" or "The Great Bear". The Great Bear is usually shown with the handle of the Big Dipper serving as its tail. (Seeing the rest of the Bear, or of most constellation figures, requires some imagination.)

Many of the stars have Greek letters attached to them. This shows the most common way of naming the brighter stars. These stars can be specified by the letter plus the constellation name. Thus, the star at the end of the tail of the Great Bear can be called Eta Ursae Majoris. (The added "is" is a Latin version of "belongs to.") These letters are called Bayer letters, after the astronomer who first assigned them. Usually, they are in order of brightness within a constellation, i.e., Alpha is brighter than Beta which is brighter than Gamma, but not always. All markings on stars can be turned on or off in the Star Display menu, as described later on page 22.

Also, you'll notice a legend at the lower left corner of the chart, showing the position of the cursor, the constellation you're in, the sizes of stars for different magnitudes, and some other data. As you move the cursor, the position readout will be updated.

The legend can be controlled from the legend menu (page 29).

## 5: PANNING AND ZOOMING

Guide is intended to be reasonably intuitive to use, even for those not well acquainted with astronomy or computers. First, we'll examine how to pan. Move the mouse cursor to the center of the top of the chart area, and click on the LEFT mouse button. The chart area will clear, and draw a chart at the same scale, but centered at the point you clicked on. You can recenter on any point in the chart in this manner.

You should, by the way, now see a smaller version of the Big Dipper, with its brightest star at the tip of the handle. This is the constellation Ursa Minor, the Small Bear, a.k.a. the Little Dipper. The bright star is the North Star, a.k.a. Polaris. You will notice that the arcs of the constellation boundaries center on (well, very close to) this star; it marks the celestial version of the North Pole. It's only coincidence that gives us a fairly bright star near the pole right now; the South Pole has no such luck, and at many times in the past, no bright star has been near the North celestial pole.

Next, let's try zooming out. There are many ways to do this; perhaps the simplest is to hit the divide (/) key. This will cause you to zoom out to see an area of the sky roughly twice as large in both height and width.

Because you are seeing more sky, some markings will be dropped out to avoid cluttering the screen. In particular, the Bayer letters are omitted. Usually, whenever you zoom in or out, Guide makes decisions as to what an appropriate level of clutter would be. Guide will also make stars brighter or dimmer as you zoom in or out, and will drop out dim stars as you zoom out and add them when you zoom in. There is ample control available to override Guide's judgment, through the Display menu.

If you look at the legend, you'll see that it says that you are at Level 2. You can now zoom out one more level, to Level 1, and no farther. This takes you to a point where you are seeing half of the entire sky and only the brightest stars.

Zooming in can be done by hitting the asterisk (*) key. You'll see the reverse of the Zoom Out process occur. You can keep on zooming in to Level 20, though there is usually not much to see past Level 10 or so, because the stars only go to about magnitude 14 or 15. The deeper levels are mostly useful in examining surface details on planets and their satellites.

The asterisk and division keys, by the way, can be used at any time and at any level in the program. In other words, they are



program-wide hotkeys. A list of program-wide hotkeys is found in the Appendices on page 85.

You can also go directly to a particular level in four different ways. To go to a level from 1 to 9, hit a key from 1 to 9 (using the numbers above the letters on the keyboard). To go to level 10, hit the 0 key. To go to levels 11 to 19, hit Alt-1 to Alt-9.

Alternatively, you can move the mouse over the line in the legend showing the current zoom level. As you do so, a box will appear around the zoom level text in the legend. Click there, and a dialogue box will appear, listing all twenty levels. Click on one, and Guide will go to that level. The effect is the same as the 1-9 and Alt-1 through Alt-9 keys; the only difference is that you need not hit the keyboard. (If the legend isn't shown, or if the current zoom level isn't shown in the legend, just hit the ')' key; this will bring up the dialogue box.)

Also, by default, the toolbar will show buttons for zoom level 1 (covers 180 degrees, a full hemisphere), 4 (covers 20 degrees), 7 (2 degrees), and 10 (1/2 degree). These are levels commonly used by many people; you can select other levels to be used using the Toolbar option in the Settings menu, described on page 37.

Finally, if you press and hold the left mouse button at the point on the chart you want to move to, and then move the mouse, you'll drag open a rectangle centered on that point. When you let go, you'll zoom into that rectangle. This is very similar to the way you can "drag a box" in some drawing programs. (There is, as yet, no equivalent way to zoom out.)

By combining panning and zooming, you can move fairly quickly from any point in the sky to any other. However, to find a particular object, you might have to do some hunting, bringing us to our next chapter.

## 6: FINDING OBJECTS

There are many different kinds of objects in the sky and many different ways in which they are named, which is why the problem of finding objects is given a menu of its own, the "Go To" menu. You can reach this menu at any time with the Alt-G hotkey. It not only provides a way to find objects; it also provides the controls to enter celestial coordinates and find compass points on the horizon.

When in this menu, you will see the following list of ways by which you can find an object:

```
Messier
NGC
IC
```

```
---------------
Horizon Menu
Satellite
Planet
Comet
Asteroid
---------------
Star
Nebula
Open Cluster
Globular Cluster
Constellation
Galaxy
---------------
Coordinates
Go To .TDF object
```

The "Galaxy" option includes "clusters of galaxies" as well.

The star, galaxy, nebula, and coordinate options are sufficiently complex to merit their own subchapters, which follow this one. This chapter will discuss the remaining options.

To find an object by its Messier number, you would click on the "Messier" menu item, and would be asked to "Enter Messier number:" When you do this, Guide will recenter on that object. If you prefer, you can also reach this option by just hitting 'm', instead of clicking on the menu options.

The NGC (New General Catalog) and IC (Index Catalog) are more detailed versions of the Messier catalog, containing a combined total of over 13,000 objects. Once again, you can find an object in either of these catalogs by clicking on its menu item and typing its catalog number, just as with Messier objects. You can also reach this option by hitting 'n' on the keyboard, instead of clicking on the menu options.

The "Horizon Menu" option lets you find points on the horizon. It brings up a small dialog box listing eight compass points on the horizon, plus the zenith (point directly overhead) and nadir (point directly below you). Click on one of these ten buttons, and Guide will center the chart there. There is also, of course, a Cancel button.

You can also reach the Horizon menu at any time with the Alt-W hotkey.

The "Satellite" option will prompt you to enter the name of an artificial satellite. You don't necessarily have to be complete here; for example, entering "mir comp" will find the Mir Complex. Enter a satellite name, and Guide will recenter on that satellite.



You can find a planet (or the Sun or Moon) with the "Planet" option, which provides a list of planets from which to choose. This option also lists the four large moons of Jupiter and the eight primary moons of Saturn. You can bring up this dialog box with the '=' key at any point in Guide.

Click on the "Comet" option, and Guide will list the comets that are currently visible. Click on one of them, and Guide will recenter the chart on that comet. Guide's definition of "currently visible" is governed by the Data Shown menu; if you've chosen, for example, to display comets down to magnitude 14.3, then this option will only list those comets brighter than magnitude 14.3. You can reach this option at any point in Guide by hitting the Alt-K hotkey.

It should be emphasized that this option shows only the currently visible comets, as defined in the Data Shown dialog (p. 24). You can get cases where Guide is only showing the two or three brightest comets, and then only those two or three will be listed.

When you click on the "Asteroid" option, you'll be asked to specify an asteroid. You can do this in any of three ways: name, number, or provisional designation. Many asteroids have names, such as Ceres, Chiron, or Toutatis. Type in a name, and Guide will recenter on that asteroid.

Asteroids are also given numbers; in the above cases, Ceres is 1, Chiron 2060, and Toutatis 4179. (Often, an asteroid will be mentioned by number, then name, as in "3 Juno" or "5145 Pholus".) Enter a number, and Guide will recenter on that asteroid.

Finally, most asteroids are given a "provisional designation" when they are found. This is usually a date followed by one or two letters, such as 1989 AC. (Later, when the object has been observed often enough that its orbit is well determined, it is given its number and, usually, a name.) Enter the provisional designation, and Guide will recenter on that asteroid.

You can also find an asteroid at any time by hitting the ';' hotkey.

Bright open clusters are usually given Messier, NGC, or IC numbers. Those that are not are given numbers in other catalogs, such as Collinder, Tombaugh, or Berkeley. For a list of these catalogs, you can click on the "Open Cluster" menu item. Select a catalog, and you will be asked to type the number of the desired cluster in that catalog, and Guide will recenter on that object.

The "Globular Cluster" option lists non-NGC/IC globular clusters. Globular clusters are huge collections of up to millions of stars, packed into dense balls. They form a loose halo around our galaxy (and around most other galaxies), and contain some of the oldest stars in the universe. Examples are Messier 13, Omega Centauri,

and 47 Tucanae.

Many globulars do not appear in the NGC or IC catalogs; without this menu, there would be no way to find them. Examples are the Palomar and Terzan series of globulars. Click on a globular cluster name in this menu, and Guide will recenter on that object.

The "Constellation" option lists the 88 recognized constellations. Click on one, and Guide will recenter on it. You can reach this option at any point in Guide by hitting the greater-than (>) key, or by clicking on the constellation abbreviation shown in the legend area.

The "Go to .TDF" option is used to find objects in user-added datasets. (User-added datasets are described in more detail on page 66.) When you click on this option, Guide will bring up a list of currently installed user datasets. Click on one, and you'll be prompted to enter the name of an object in that dataset. If Guide can find that object, it will recenter the chart on it.

### 6a: Finding stars

When you click on the "Star" option in the "Go to" menu, you will get the following menu:

```
Bayer/Flamsteed
Yale (Bright Star)
SAO
PPM
HD
Guide Star Catalog
Common Name
Variable Star
NSV
Double Star
Supernova
DM (Durchmusterung)
Hipparcos
Nearby star
```

Each of these represents one of the many ways devised to specify a star.

The "Bayer/Flamsteed" option lets you specify a star by its Bayer (Greek) letter or Flamsteed number. Bayer letters were mentioned on page 5; they are used to refer to objects as "Alpha Centauri" or "Gamma Cygni" or "Mu Cephei", for example: a Greek letter followed by a constellation. Flamsteed numbers are used to refer to slightly dimmer stars as well; they consist of a number followed by a constellation, such as "40 Eridani" or "61 Cygni".

When you click on the "Bayer/Flamsteed" option, you will see a



list of the 88 constellations. Select the one you want, and you will see a list of Bayer and Flamsteed objects in that constellation. (You'll notice that the Bayer objects will often have a Flamsteed number as well.) Click on the object you want, and you will recenter on that object.

If you're a 'keyboard' oriented person rather than a 'mouse' oriented person, you might prefer to use another method to find Bayer and Flamsteed stars. If you hit Ctrl-B, you'll be asked to "Enter Bayer designation:" If you enter a star designation such as "Zet Tau" or "Gam2 And" or "61 Cyg", Guide will recenter on that object. (This option will also recognize common names such as "Capella" or "Betelgeuse".)

The Yale (Bright Star) Catalog, also known as the HR catalog, lists 9,096 stars. It gives a lot of information about stars that is mostly of interest to professionals and gung-ho amateurs, that will be described later. When you click on the "Yale (Bright Star)" menu item, you will be asked to enter an HR number. Do so and hit Enter, and Guide will recenter the chart on that star.

The SAO (Smithsonian Astronomical Observatory) catalog lists 258,997 stars, but has less information per star than the Bright Star Catalog. This catalog gets a lot of use in astronomy magazines, which will often define a star by its SAO number. When you click on the "SAO" menu item, you will be prompted to enter an SAO catalog number. Enter one, and Guide will recenter the chart on it.

The PPM (Position and Proper Motion) catalog lists slightly more stars than does the SAO catalog. It is a more recent catalog, and was intended as a more accurate replacement for the SAO. Click on this option and enter a PPM number, and Guide will recenter on that PPM star.

The HD (Henry Draper) catalog was compiled early in this century, and lists over 359,000 stars. Click on this option and type an HD number, and Guide will recenter on that HD star.

Receiving less use than the other catalogs, the "Guide Star" option lets you find a star by Hubble Guide Star Catalog number. This catalog lists over 15 million objects (and forms the basis of the more detailed layers of Guide's data), but provides no more information about each star than its location and brightness (or magnitude. See page 83 for a discussion of astronomical magnitude.)

A GSC designation consists of a zone number, ranging from 1 to 9537, and a star number within that zone, usually (but not always) less than 10000. To find a GSC star, click on the "Guide Star" option. You will be prompted to enter the star's GSC zone and number. Do this, and Guide will recenter on that star.

Many of the brighter stars have names handed down from ancient

civilizations: Betelgeuse, Sirius, Capella, Antares, and so on. The "Common Name" option lets you find a star via these names.

Clicking on this option brings up a list of over 290 common names for stars. You can hit the letter Z and automatically see the first "Z" star in Guide's list, or click on the scroll bars, or use the cursor keys.

When you find the star you want, click on it and Guide will redraw the chart centered on that star. (Alternatively, of course, you can use the Ctrl-B hotkey mentioned near the beginning of this chapter.)

Another commonly used designation for a star is a variable star designator. Variable stars vary in brightness. Sometimes this takes place over years; sometimes over minutes. Sometimes the variations are a thousandfold; sometimes it requires precise measurements to detect the changes. The reasons range from cases where two stars orbit one another and eclipse each other as they do so, to stars that physically swell and shrink, to stars that occasionally have major explosions.

Variables are usually designated by one or two letters and a constellation, such as R Coronae Borealis (R CrB) or UV Ceti (UV Cet). Under the rules used for these designations, there are only 334 designations per constellation; after this point, further variables are given a number following a V. Thus, V335 Ori is the first variable found in Orion after letter designations were exhausted.

You can find a star by variable designator by clicking on the "Variable Star" option. Type in the variable designator, either one or two letters or V followed by a number, plus the three letters for the constellation. Guide will recenter on that star. (You can also reach this by hitting the backslash, "\", key, or Ctrl-V, at any point in the program.)

The NSV (New Catalog of Suspected Variables) is mostly of interest to variable star observers. It lists over 14,000 stars that someone has thought might be a variable, but which haven't been studied well enough to be sure of the matter. Click on this option and enter an NSV number, and Guide will recenter on that star. (You can also reach this through the Ctrl-N hotkey at any point in the program.)

The "Double Star" menu option is used when you want to find a star by its designation in a double star catalog, such as the ADS (Aitken Double Star) or Struve number. When you select this option, you are provided a list of over 130 double star catalogs (all named after their discoverers). Click on one and enter the number of the star in that catalog, and Guide will recenter on that star.

The "Supernova" option lets you find supernovae that have occurred in other galaxies. Over a thousand have been observed; the first was



in our neighboring galaxy, M-31 in Andromeda. With the exception of that supernova and one in the Large Magellanic Cloud in 1987, no supernova outside our galaxy has been bright enough to be visible to the unaided eye.

When you click on the "Supernova" option, you'll be prompted to enter the supernova's designation; examples are 1993J and 1885A. Guide will then recenter on that object.

The "Durchmusterung" option provides a way to find stars in the four catalogs of the DM Catalog. These are known as the Bonner Durchmusterung (BD), which covers stars in the northern half of the sky; the Sudentliche Durchmusterung (SD), which covers stars between declinations -1 and -23 degrees; the Cordoba Durchmusterung (CD), which covers declinations -22 to -90; and the Cape Photographic Durchmusterung (CP), which covers -18 to -90. You'll notice that these catalogs overlap in places.

When you click on this option, you'll be prompted to "Enter DM number:" You do have to provide the catalog abbreviation (BD, SD, CD, and CP), followed by the zone number, followed by the star number. For example,

BD +32 724
CP -67 1233

are examples of valid entries for this option.

The "Hipparcos" option will cause Guide to ask for an Hipparcos catalog number. Enter one, and Guide will recenter on that object.

The "Nearby Star" option will bring up a list of nearby stars. Many of these have odd names such as "Proxima Centauri", "Barnard's Star", or "Kruger 60", that won't appear in any of the standard catalogs. This function can be especially useful in such cases.

### 6b: Finding galaxies

When you click on the "Galaxy" option in the "Go to" menu, you will get the following menu:

```
PGC
Uppsala
MCG
ESO/Uppsala
CGCG
Markarian
Abell Cluster
Zwicky Cluster
Common Name
Hickson
```

You'll notice that this provides several ways to find both galaxies and clusters of galaxies.

The PGC (Principal Galaxy Catalog)/LEDA lists extensive data for over 160,000 galaxies, and is the fundamental galaxy catalog used by Guide. When you click on a galaxy and click for "more info", the information shown comes (mostly) from this catalog. To find an object by its PGC/LEDA number, click on the "PGC" menu option and enter the PGC number. (The terms "PGC" and "PGC/LEDA" will be used interchangeably. The LEDA data is a recent extension to the PGC.)

The UGC (Uppsala Galaxy Catalog) is an older catalog of over 10,000 galaxies. To find an object by its UGC number, click on the "Uppsala" menu option and enter the UGC number.

The MCG (Morphological Catalog of Galaxies) is another older catalog, containing data for over 30,000 galaxies. An MCG designation consists of three numbers, with spaces or dashes between them; the first number can be negative. Sometimes, a letter is added on, as in "MCG -04-12-133A". To find an object by its MCG designation, click on the "MCG" menu option and enter the MCC designation. You can use either dashes or spaces to separate the three numbers; for example, "-4 12 133a" will work as well as "-04-12-133A".

The ESO/Uppsala (European Southern Observatory) catalog extends the Uppsala catalog to the southern sky; the CGCG (Catalog of Galaxies and Clusters of Galaxies) is commonly used for labelling northern galaxies. In both of these catalogs, galaxies are designated by two numbers, again separated by a space or dash, as in "ESO 34-12" or "CGCG 17 41". Again, as with the MCG, a letter is sometimes added to this.

To find a galaxy by its ESO or CGCG designation, click on either the "ESO/Uppsala" or "CGCG" options, and enter the designation. Again, you can use either a space or dash to separate the two numbers.

The Markarian catalog contains around 1,400 galaxies, far fewer than the catalogs previously discussed. It lists "active galaxies", such as Seyfert galaxies and quasars: galaxies that emit prodigious amounts of energy.

The Zwicky and Abell catalogs lists "clusters of galaxies". These objects are not very easy to find, unless you have access to an unusually large telescope. Both of these catalogs were assembled because if you study enough of them, it is possible to determine information about the size and age of the universe. The Zwicky catalog lists 9,134 clusters in the northern sky. The Abell catalog lists over 5,000 clusters in all parts of the sky.



By the way, don't confuse the Abell catalog of clusters of galaxies with the Abell catalog of planetary nebulae (p. 15).

Also, one can find a galaxy in the "Common Name" section. There are many galaxies that are better known by a name than by their catalog numbers. For example, M-51 is better known as the Whirlpool Galaxy, and NGC 5128 is better known as Centaurus A. Clicking on "Common Name" leads to a menu listing some of these objects.

One can also find a galaxy by its Hickson designation. The Hickson catalog lists 100 compact clusters of galaxies, similar to Copeland's Septet and other close groupings. The Hickson designation consists of a number from 1 to 100, followed by a letter; for example, Hickson 42E would be the fifth galaxy found in cluster #42.

Finally, one can find a galaxy by its Arp number. The Arp catalog contains 338 "peculiar" galaxies and groups of galaxies listed by Halton Arp. Many of these objects make for interesting observing with small telescopes, and are good targets for amateurs. Clicking on this option will result in being prompted for an Arp number; enter a number (from 1 to 338), and Guide will recenter on that object.

**6c: Finding nebulae**

When you click on the "Nebula" option in the "Go to" menu, you will get the following menu:

```
Sharpless
Lynd's Bright Neb
PK (Strasbourg)
Van den Bergh
Barnard Dark Neb
Common Name
Abell Planetary
```

To find an object by its Sharpless, Lynd's Bright Nebula, Abell, van den Bergh, or Barnard number, click on the option and type in the catalog number; Guide will recenter on that object.

By the way, don't confuse the Abell catalog of planetary nebulae with the Abell catalog of clusters of galaxies (p. 14).

The PK (Perek-Kohoutek), or Strasbourg catalog of nebulae, requires a pair of numbers. (These numbers actually form a coordinate for the object.) For this option, you enter both numbers, as in "249-5.1" or "215+11.1". The numbers will be separated by either a plus or minus sign.

Most nebulae are known by their common names, such as the Eskimo nebula or the Trifid nebula. The "Common Name" menu provides a list

of these names from which to choose.

**6d: Entering coordinates**

Guide has provisions for entering coordinates in four different systems: equatorial (RA/dec), ecliptic, galactic, and alt/az. Because entering coordinates is a fairly common task, Guide provides several ways to go about it; you can then choose the method you find best.

If coordinates in any of these systems are shown in the Legend, you can just click on those coordinates and Guide will prompt you to enter new coordinates. For example, if the RA/dec is shown in the legend, you can click on it and Guide will ask for a new RA/dec. If the altitude/azimuth is shown, you can click on that and Guide will ask for an alt/az position... and so on.

Also, you can select any of these coordinate systems from the Coordinates menu, under the Go To menu. The Coordinates menu also has an "Opposition Point" option, to find the point directly opposite the sun. (You can also find the opposition point with the Alt-U hotkey.)

When entering an alt/az position, you will be asked to enter the altitude first. This can range from -90 (straight down, the "nadir") to zero (a point on the horizon) to 90 (straight up, the zenith). Next, you will be asked to enter an azimuth, or "bearing". This can range from zero (due north) to 90 (due east) to 180 (south) to 270 (west) to 360 (north again). Guide will then recenter on the position given. A description of alt/az is given in the Appendices, on page 79.

If the coordinates aren't being shown in the Legend, and you prefer not to navigate through the menus, you still have two choices. One is to toggle the display of those coordinates; this is quite simple to do, and is described on page 29. Your second option would be to use one of the following hotkeys:

'ALT-E' for equatorial (RA/dec) coordinates;
'ALT-.' for galactic coordinates;
'ALT-,' for ecliptic coordinates;
'&' for alt/az coordinates.

A comment on entering RA/dec positions. Guide is quite willing to accept the many forms of RA/dec coordinates; for example,

```
10h42m36.00s        N41.69
10h 42m 36s         N41 41' 24"
10h 42.6m           N41 41.6'
10.71h              +41 41' 24"
```

all refer to the same position in the sky, and all will be correctly



understood by Guide. You can leave out minutes or seconds, put spaces between fields, use +/- in place of N/S, and use decimal amounts. If Guide can't figure out what you meant, it will tell you so with an error message, and will give you a chance to try again.

Guide will not only recognize any of the formats in the above examples; it will also use those formats in future displays of coordinates. For example, if you enter a position in decimal minutes for RA and decimal degrees for declination, Guide will then proceed to show _all_ RA values in decimal minutes and _all_ declination values in decimal degrees. Use or omit leading zeroes, and Guide will use or omit leading zeroes when displaying coordinates.

If you just want to reset the format or epoch Guide uses for showing RA/dec values, without entering new coordinates, use the "RA/dec Format" option described on page 36.

There is also a minor difference between the DOS and Windows software here. The Windows version will provide edit boxes for the RA and declination, plus one for the epoch. The default value for this is J2000.0.

"Epoch J2000.0" tells you that, by default, all positions are shown and are expected to be entered in the J2000.0 epoch. (An explanation of "epoch" can be found in the Appendices, on page 77.) It is not likely that you will disturb this, but suppose you were given the position of an object in B1950 coordinates. (Many older catalogs are still unconverted from B1950 coordinates, so this is a common occurrence.) You would change this item to B1950.

This epoch is used throughout Guide. Not only is it the epoch used when you enter a position; it is also the epoch in which your current position is shown, and in which all positions are shown in ephemeris and "more info" data. (There are a few exceptions to this in the "more info" section. They are all given clear labels such as "J2000", "B1950", "coordinates of date", and so forth, so that you can clearly distinguish them.)

In the DOS version, resetting the epoch is always done separately; you click on the epoch shown in the legend, or use the RA/dec Format option in the Settings menu. The result is the same under either DOS or Windows.

## 7: GETTING INFORMATION ABOUT OBJECTS

What Guide shows you on the screen is a fraction of what it knows about what's on the screen. Since Guide can't show everything at once, you get extra data about most objects by clicking on them. This gives you a quick summary of important data about the object: its name, catalog number(s), rise/set times, and so forth. If you're interested, you can then ask for full information about the

object, including everything Guide knows about it. You can also export that information to an ASCII file, for use in a word processor or other software, or simply print it directly.

To see this, get to level 3 and go to the star Acubens. You can do this by clicking on "Go to", then "Star", then "Common Name", and finally on the name "Acubens". (Or, you can just hit Ctrl-B and enter "alp cnc" at the prompt.)

If you now click on Acubens with the RIGHT mouse button, a dialogue box will pop up in the center of the screen, telling you that the star you clicked on is called Acubens, or Sertan; that it is Bayer letter Alpha, Flamsteed number 65, in the constellation Cancer; it will give you the time the star rises and sets; and it will tell you the star's altitude and azimuth (where it would be in the sky at that time.) It also tells you the PPM, SAO, HD, Yale, and Hipparcos catalogue numbers for the star, its spectral type, and that this is a magnitude 4.65 object. ("Magnitude", or brightness level, is discussed on page 83.)

You'll notice that the very bottom line in the box provides three buttons, "OK", "More Info", and "Next". If you click on the "OK" button, the information will vanish. If you click on "Next", Guide will search the chart again and return information about the next nearest object. This can be handy in crowded areas or with overlapping objects, where your first click may not get the desired object; in such cases, you can click "Next" until Guide finds the object you really wanted.

If you instead click on "More Info", the screen will clear and be replaced by further information. The amount and type of information will depend on the object. For bright objects, Guide may be able to find information in a half dozen catalogs; for obscure objects, perhaps only one.

If you click on Acubens, for example, and then click on "More Info", you will get about 150 lines of data (Guide happens to know a great deal about this star). It will start out with data from the Hipparcos catalog, giving such details as position, magnitude, proper motion, numbers in various catalogs, and so forth. You'll notice that several words are in light blue; you can click on them to get information about them. In fact, the remarks data is an extension of the help system, so you can get added information about the remarks in the same way. As with any part of the help system, you can save the data to a file or print it.

After Guide lists the raw data from the Hipparcos data, plus some information such as distance and luminosity derived from that data, it gives information from the Tycho, GSC, PPM, SAO, WDS, HD, and Yale Bright Star catalogs. All this serves several purposes. Some of the other catalogs just give data backing up the information from previous catalogs. A few provide unique



information; for example, the WDS (Washington Double Star) catalog tells us that this is a double star, with magnitudes 4.25 and 11.8. A catalog such as the GCVS will tell you what type of variable star this is, and how much it varies by, and what its period of variation is.

For many people, this amount of detail will be much more than they really want to know, and some of the terms used will be somewhat baffling. The links to the help system are usually helpful in this regard, though; if terms such as "proper motion" are new to you, a mouse-click on them will bring up a definition.

When you click for more info on a planet, Guide will give you some data as to its position, distance from you, apparent size, and what percentage of its surface is illuminated. In the case of the Sun, it will also give you times when the three different kinds of twilight begin and end.

In the case of the Moon, "more info" will also include data about phases, lunar eclipses, and librations. The Moon rotates at a constant rate, but its orbital speed is not exactly constant; this makes it appear to rock back and forth. Also, its poles alternately tip toward and away from us slightly. The end result is that, instead of seeing only one side (50%) of its surface, we see a little more (about 59%). The libration data will tell you what part of the moon is currently tipped toward you, which will make that part more easily observed than it might usually be.

In the case of Jupiter, "more info" will include a schedule for satellite events (eclipses, transits, etc.) over the next week.

### 7a: Measuring angular distances on the screen

Guide provides a simple way to measure the angular distance between any two points on the screen. Click with the RIGHT mouse button on the first point; holding the mouse button down, drag the mouse over to the second point. As you do so, a line will "rubber band" between where you clicked and where the mouse is.

When you release the right mouse button, the distance and position angle between the two points will show up in a box in the center of the screen; you can click any mouse button or hit any key to get rid of the box. The "position angle" is the angle formed by the line you drew and a line running straight north from the first point. It's a term commonly used to describe how a pair of double stars is oriented, or how the long axis of a galaxy is oriented, and so forth.

There is a variation to this that can be useful when you want, say, an exact distance and position angle between two objects. Right-click on the first object; you will see a short information box, just as described in the preceding chapter. Click OK, and repeat the process

with the second object. Now hit Insert (Ctrl-Insert if you're using DOSGUIDE).

Guide will now compute exact data between the two objects, which allows you to avoid measuring errors. In general, just dragging a line between two points will work well enough; but there are cases where you may want a truly precise value.

### 7b: Quick Info

There is a certain sort of general-purpose information for which one usually wants easy access: planet positions, twilight times, and so forth. The "Quick Info" option in the Help menu lists much of this sort of data.

Click on it, and Guide will list planetary positions, times of lunar phases, current local and Greenwich sidereal times, comets brighter than magnitude 15, asteroids brighter than magnitude 11, the current equation of time, and similar data useful for planning an observing session. It will also give the current limiting visual magnitude for the currently centered part of the sky for the currently set time, using a method described by Bradley E Schaefer in the May 1998 issue of Sky & Telescope.

## 8: DISPLAY MENU

The Display Menu provides most of the control over the objects shown by Guide and the manner in which they are displayed. You can also reach this menu at any point in the program by hitting Alt-D (in DOS) or Alt-Y (in Windows). By default, this menu shows the following items:

```
Star Display
Data Shown       (Windows only)
Dim Stars
Brighten Stars
Zoom Out         (Windows only)
Zoom In          (Windows only)
Border
Legend
CCD Frame
Inversion Menu
Ticks, Grids, Etc.
Screen font      (Windows only)
Printer font     (Windows only)
Direct to screen (Windows only)
Background
Isophotes
```

Clicking on the Star Display option brings up a dialog box with controls over how stars are labelled, their sizes, and whether they



are colored by spectral type. This dialog is discussed in detail on page 22.

The Data Shown option brings up a dialog box showing the types of celestial objects shown by Guide (variable stars, galaxies, etc.) and providing control over how they are shown and labelled. This option is discussed in detail on page 24. (In DOS, this menu option appears in the main menu.)

The "Dim Stars" and "Brighten Stars" options provide control over the limiting magnitude used. By default, Guide will show a "reasonable" number of stars at any zoom level; at a 180 degree field of view, only the brightest naked-eye stars are shown, while at a telescopic field of view, stars down to magnitude 15 will be shown. These two options provide some adjustment to the default values.

Hit "Brighten Stars", and the limiting magnitude will be increased; stars already shown will become larger, and dimmer stars will be added to the chart. "Dim Stars" does the reverse. You can reach both options with the '+' and '-' hotkeys.

The "Zoom In" and "Zoom Out" options zoom in and out by one level at a time. They have exactly the same result as the divide (/) and multiply (*) hotkeys, as discussed previously on page 6.

The Border option puts a border around the chart, and can be toggled on or off. Most people use it to add borders to printed charts.

The Legend option is checked when the legend is turned on. In DOS, clicking on the option toggles display of the legend; when you turn the legend on, the Legend dialog comes up. In Windows, clicking on this option simply brings up the Legend dialog, and you turn the legend on or off from this dialog. The Legend Dialog is discussed in detail on page 29.

The CCD Frame option toggles the display of a "camera frame", a resizable rectangle you can use to indicate the area of sky covered by a CCD or film camera. When you turn it ON, the Frame menu will appear, which allows you to position, resize, and tilt the rectangle. The Frame menu is discussed on page 27.

The Inversion option brings up a dialog box that lets you reset the orientation of the chart. You can use it to make charts that are flipped north/south, east/west, or both. You can also use it to put the zenith at the top of the charts instead of celestial north, or ecliptic north, or galactic north; and in addition to that rotation, you can add an arbitrary amount of rotation to the charts. The Inversion option is discussed on page 39.

The "Ticks, Grids, Etc." option provides controls over all the

markings used to illustrate measurements and coordinate systems: grids, ticks, hatches, the Telrad sight, and so on. It is discussed further on page 30.

The "Screen Font" and "Printer Font" options are only available in the Windows software (DOS, unfortunately, offers no alternative fonts.) If you click on these options, Guide will show a dialog box with the currently selected fonts for the screen or printer. Choose a new one, and Guide will swap to using it on that device.

The "Direct to Screen" toggle option is also available only in Windows. Usually, Guide draws a chart on the screen by erasing the background and drawing stars, overlays, text, and objects in the window. You see the whole process as it happens. This is the default mode, where things are drawn "directly to the screen".

Turn this option off, and Guide draws the chart in memory, then displays it all at once on the monitor. The major benefit is that (on some video cards) this can be much faster than the default mode. No clear pattern has emerged as to which is faster, and some people just prefer not to see the process of the chart being created. It may be best just to try it and draw your own conclusions.

Also, there are some animation activities where turning off "direct to screen" is almost essential; these will be discussed on page 52.

The Backgrounds option provides a way to switch from the default "white stars on black" to "black stars on white"; or to a "red mode" for use at the telescope; and to control the display of objects (trees, houses, mountains) on the horizon, or to have the ground filled in a solid color. It is discussed on page 32.

By default, Guide shows the Milky Way in assorted shades of gray at wide fields of view, and switches to showing individual nebulae at narrower fields of view. Most of the time, you'll probably want to leave display of these objects turned on. But you can use the Isophotes toggle to turn them off, if desired.

The isophotes for nebulae were generated from the RealSky CD-ROMs (described on page 58), and therefore set new standards for accuracy and detail. The main problem with this approach is that the RealSky CDs stop at declination -16, and leave out all southern nebulae. It is hoped that the RealSky South CDs will be available soon, and will allow this problem to be remedied.

## 8a: The Star Display menu

The Star Display menu contains controls for setting how stars are labelled and displayed. You can reach it from the Display menu; or by hitting the '#' hotkey; or by clicking on the magnitude key shown in the legend area (the part showing what star size corresponds to which



magnitude).

No matter which method you use to reach the Star Display menu, the options provided to you will be:

```
Limiting magnitude:
Color Stars
Outlined Stars
Mag Range 10
Min Star Size 0.5
Max Star Size 30
Common Names Off
Bayer Auto
Flamsteed Auto
SAO Numbers Off
PPM Numbers Off
GSC Numbers Off
HD Numbers Off
HIP Numbers Off
Yale Numbers Off
Mag Labels Off
Non-Stars On
```

The first option is nearly self-explanatory; it provides a way to set the limit Guide goes to in drawing stars at the current level. Some caution is necessary here. If you tell Guide to draw to, say, magnitude 14 at a 180-degree field of view (level 1), it will attempt to do so. But since about 5 million stars will be drawn, it will take a long time and look very messy.

The next two options affect how stars are drawn on the screen. They are best understood by trying them. When "Outline Stars" is turned on, dim stars on top of bright stars are bordered in black, making them visible. This is the method usually used in printed charts. When the "Color Stars" item is turned on, stars are colored by spectral type: red for cool class M stars, blue for hot type O stars, yellow for class G stars such as the Sun, and so forth.

Be aware that "Color Stars on" only has an effect at levels 1 to 6, where spectral information on stars is available, and only when in a 256-color or high-color mode (there aren't enough colors to do this in 16 color modes). (Actually, it can also have an effect at deeper levels when showing A1.0 and SA1.0 stars, which also have color information. Details on A1.0/SA1.0 are given on page 60.)

The "Mag Range" and "Star Size" items let you adjust the size of the circles used to display stars. The brightest star visible in Guide (Sirius) is about five million times brighter than the dimmest. This range can't be represented on the monitor; by default, Guide provides a range of ten magnitudes. You may want to cut that back, particularly when printing to a low resolution printer. You may also want to set

just how large or small a star can be. You can use these lines to control all three parameters: minimum and maximum star radius, and the range of magnitudes that can be shown.

Most of these items are telling you that a marking is set on "Auto", meaning that Guide automatically makes decisions as to whether they are shown or not. This is similar to saying that it's a bad idea to show city names on maps of the world or of individual rooms, but a good idea somewhere in between. When a marking is on Auto, Guide uses a predetermined set of rules designed to minimize clutter.

The next nine items all control the display of labels for stars. They cycle from Auto to On, then to Off, then to Auto again: a three way switch. When a marking is on On or Off, Guide will ignore its own judgment and either always show or always not show the marking.

The "Mag Labels" option provides a way to label all stars, down to any particular brightness level, by magnitude. The idea is that you might have a condition where your chart shows stars down to magnitude 15, but you really don't want all of them labelled by magnitude; it would be too crowded. So you would set a limit of (perhaps) magnitude 11 here.

The final item, "Non-Stars On", controls the display of objects labelled as "non-stars" in the Hubble Guide Star catalog. The GSC was automatically generated, and a computer classified non-starlike objects on the photographic plates (scratches, asteroids, galaxies, nebulae, and some stars that confused the computer) as "non-stars". Most are really misclassified stars, which is the reason Guide displays them by default. Usually, you will want to see them; if not, you can shut them off with this switch. Guide shows them as green stars.

## 8b: The Data Shown menu

The Data Shown menu (reachable at any time by the Ctrl-D hotkey) lets you control what celestial objects are shown on the chart, and the manner in which they are shown. In the DOS versions, it shows up as a menu; in the Windows version, it is shown as a dialog box. The same functions are provided in each case, but they are not in exactly the same places.

In both versions, you are given a list of 14 classes of objects controlled by the Data Shown menu/dialog:

Messier
NGC + IC
Galaxies
Nebulae
Planets



Variables
NSV
Open clusters
Asteroids
Gal Clusters
Comets
Globulars
Planetaries
Dark Nebulae
Satellites

In the Windows software, each object class is followed by buttons to turn that class "on", "off", or "auto". Most classes can be shown to a limiting magnitude, and the color used in drawing that class can usually be set. In DOS, you have these same features, but you have to click on the name of the object class to get at the settings for that particular class.

When a particular class of objects is turned On, all objects of that class will be shown, regardless of magnitude. When Off, none will be shown. When set to Auto, all those brighter than the magnitude limit for that class will be shown.

In the DOS software, if you click on an item set on Auto or On, you will simply turn it Off. If you click on an item set to Off, you get the small menu providing control over the limiting magnitude, color, the toggle between Auto and On for the class, and possibly some other items.

If a class of objects is set to On or Off, its magnitude limit is irrelevant, and is therefore grayed out. When you switch to Auto, you can set the limiting magnitude for that class of objects. You can use it, for example, to display all asteroids brighter than mag 10, all variables brighter than 11.3, no galaxy clusters, and so forth.

The magnitude limit will be raised or lowered when you zoom in or out. If you're observing mag 8.0 asteroids at level 4, for example, that will be raised to mag 14.5 at level 9. This simply makes sure that as you zoom in, you see dimmer objects, as occurs with stars.

In the DOS software, three object classes will show extra menu selections when clicked on. (In Windows, the same controls are provided right in the main Data Shown dialog itself.) The "Gal Clusters" menu will show a three-way switch between Zwicky On, Abell On, and Abell + Zwicky On. The Abell catalog of clusters of galaxies covers the entire sky, and contains over 5,000 objects. The Zwicky catalog only covers the northern half of the sky, but it has over 9,000 objects. Some objects are found in both catalogs.

Depending on where you are in the sky, you may wish to see the Abell clusters, the Zwicky clusters, or both. All three are possible,

and a check mark is placed in the menu beside the current selection.

In DOS, the Asteroids submenu will show some extra options. In addition to limiting the display of asteroids by magnitude, you can also set limits based on the asteroid's orbit. Perhaps the best way to explain how and why to use these limits is by an example.

Suppose you wanted to show all asteroids that venture between the orbits of Mars and Earth. This is roughly a range of 1 to 1.5 AU. You would click on the lower axis menu item, the one reading "No Lower Axis Limit", and type in 1, and then click on "No Upper Axis Limit", and type in 1.52. Henceforth, only asteroids crossing into that region would be shown. Clicking on them again restores the original situation of no limits. Similarly, this allows one to show only the Trojan asteroids (set the limits to 5.2 to 5.2 AU), or only those inside the Earth's orbit (set the upper limit only, to 1 AU), or those in the Kuiper belt (set the lower limit to about 25 AU).

By default, both limits are turned off, and either all asteroids are shown, or only those brighter than the magnitude limit.

In both DOS and Windows, you have additional controls over the labelling of asteroids. By default, asteroids are labelled with their number. (Unnumbered asteroids are therefore also unlabelled asteroids, and are simply shown as cross-marks.) The Asteroids submenu will provide an option toggling through four possible ways of labelling asteroids: no labels; numbered asteroids labelled; asteroids labelled by number if available, provisional designation otherwise; asteroids labelled by name, provisional designation otherwise.

Finally, the Planets submenu provides three useful switches. One toggles between showing planets with traditional symbols (the default) to showing planets labelled with their names. The second toggles between full-precision and normal precision for positions. The third turns off the detailed (but slow) bitmapped images of planets, and instead shows less detailed (but very fast) illuminated crescent/disk of the planet.

"Full" precision switches to use of the full VSOP theory. The VSOP theory ("Variations Seculaires des Orbites Planetaires") was compiled by P. Bretagnon and G. Francou of the Bureau des Longitudes in Paris. This theory allows one to compute planetary positions as the sum of a long series of trigonometric terms. When full precision is used, every one of the terms of the VSOP87 is used, and planetary positions are precise to roughly .01 arcsecond. The only drawback to full precision is that computing all those terms can be slow, especially on older computers. (If you have a Pentium, you may not notice the slowdown.)

"Normal" precision is the default, and provides a precision of



about an arcsecond over the period 0 AD to 4000 AD. It is also based on the VSOP87, but omits many of the smaller terms; it is the truncated version used in Jean Meeus' _Astronomical Algorithms_ (Willmann-Bell, 1991).

For most uses, "normal" accuracy is more than sufficient. But there are a few professional astronomers with a need for the higher level of accuracy, and it does allow Guide to claim greater accuracy than other software.

The "Bitmap Planets" option defaults to being checked. In this case, when you zoom in on a planet such as Jupiter or Mars, you will get an excellent rendition of how the object would look at that moment from your viewpoint. Features such as the Great Red Spot will be placed properly; if the object is being eclipsed by another object, the shadow will be shown, with the penumbra shaded; the rings of Saturn will be shown with proper intensities, and shade the surface of Saturn correctly.

This looks beautiful, and can be useful in planning observing sessions. The only drawback is that it requires quite a bit of math. Even Pentium users will notice a little slowdown when a planet is drawn in this manner. It can really slow animation down badly, especially if you zoom in very far on the planet. Turn the "Bitmap Planets" option Off, though, and planets will be drawn almost instantly, no matter how far you zoom in.

### 8c: The Camera Frame menu

The Camera Frame Menu, located inside the Display menu, lets you put a rectangle on the screen. You can set the size, position, and tilt of the rectangle. Normally, you would use this to show the area covered by a camera or CCD image. You can either reach it by clicking the Frame line in the Display menu to ON, or by hitting Ctrl-F.

This is one case where the DOS and Windows software differ slightly. The DOS version provides these controls in menu form; the Windows version provides a dialogue box. The DOS version will be described first; then the (minor) differences in the Windows implementation will be discussed.

The menu initially will look like this:

```
Move frame        (DOS only)
Enter frame posn  (DOS only)
Width 1.5
Height 1
Angle 163
Spin Right
Spin Left
Center Frame
```

The first two options let you reposition the frame. "Move Frame" asks you to click on the frame's new position; it will then draw the frame there. "Enter Frame Posn" is similar, except that instead of clicking on the new position, you enter its coordinates (right ascension and declination).

The next two items, logically enough, allow you to change the frame's dimensions. Click on either, and you can enter the new size (by default, the frame measures 1.5 degrees by 1 degree). You can enter just a number, in which case the dimension is assumed to be in degrees; or a number followed by a single quote ('), to indicate arcminutes; or a number with a double quote ("), for arcseconds. For example,

.5
30'
1800"

all refer to one-half degree (the same thing as 30 arcminutes or 1800 arcseconds). When you change a frame dimension, the frame is immediately redrawn at the new size.

The next three options allow setting of the tilt angle of the frame. "Spin left" and "Spin right" each rotate the frame by five degrees to the left or right; this is the most intuitive way to tilt the frame. Those of a more quantitative bent can click on "Angle", and enter the tilt angle (in degrees).

Finally, you may simply want the frame to always stay at the center of the screen, following you as you move around the sky. You can toggle this behavior by clicking on "Center Frame". When this is turned on, the first two items in the menu (Move Frame and Enter Frame Posn) are grayed out, and the camera frame is always centered on the screen.

In the Windows version, the first two options ("Move Frame" and "Enter Frame Position") are not provided; they are not particularly necessary in this case. One can simply center on the desired position for the frame, and then check the "Center Frame" box. If you want to fix the frame in that location, you would then uncheck that box.

In the Windows version, a checkbox to "Show Frame" is provided at the top of the dialog box. This provides a somewhat simpler way to just turn the CCD frame on or off.

Also, in the Windows version, the width, height, and angle controls are implemented as edit controls. The "Spin" controls work as described for the DOS software.

Also, under both Windows and DOS, there is a special hotkey for the purpose of moving the frame to a new position. Put the cursor at the desired location and hit Ctrl-F8. If the frame is turned off, this will combine the acts of turning the frame on and re-drawing it, centered on the cursor. If the frame is already on, this will simply recenter the frame.



**8d: The Legend Menu**

The Legend menu controls what is shown in the area at the lower left corner of the chart. This legend is also shown on the printed chart. You can reach the Legend menu either by clicking on the Legend item in the Display menu to ON, or by hitting Ctrl-L.

There is one difference between the DOS and Windows software that must be mentioned right away. In Windows, clicking on the Legend option brings up the Legend menu right away, with a check-box inside to turn the legend itself on or off. In DOS, the Legend option just toggles the legend display; when you turn the legend On, you get the menu described below.

When you first enter the Legend menu, it will look like this:

```
 Show Legend   (Windows only)
Show Time On
Show Lat/Lon On
Caption Off
RA/Dec On
Field Size On
Object key On
Mag key On
Compass On
Sky Atlas 2000 Off
Uranometria Off
Alt/Az On
Ecliptic coords Off
Galactic coords Off
Hour Angle Off
Add to caption
Clear Caption
```

The following options are only available in the Windows software:

```
Layout:              Position:
 (x) Vertical         (x) Bottom
 ( ) Horizontal       ( ) Top
(x) Left   ( ) Right   ( ) Center
```

As mentioned, the Windows software provides a check-box at the top of the dialog to turn the legend on or off.

Options "Show Time" through "Hour Aangle" are toggles, controlling whether an item will be put in the legend. For example, if you're producing charts showing an eclipse, the time and lat/lon

are important items that should appear on the chart. If the chart shows how to find the Double Cluster, however, the time and lat/lon are irrelevant, but the RA and declination should be shown.

You can click on many of the legend items to change them. For example, if the time is shown in the legend, clicking on it will bring up the Time menu. Clicking on the RA will bring up the "Enter new RA/dec" box; clicking on the galactic coordinates will cause Guide to ask you to enter a new chart center in galactic coordinates; and so on.

In three cases, the behavior is not so intuitive. If you click on the compass, you enter the inversion menu, which lets you specify how the chart is inverted and/or rotated; this is described in more detail on page 39. If you click on the magnitude key, you enter the star size menu, which lets you specify the sizes at which stars are to be shown and what range of magnitudes are shown (see page 22). And if some data types are shown in the Object key, clicking on them brings up the Data Shown menu (see page 24).

The "caption" refers to text you may wish to add to the legend area, such as "Occultation of P17 by Pluto" or "Area around M-49". You may wish to add multiple lines; suppose, for example, that you want to make a chart showing the asteroid 111 Ate passing through the galaxy M-104, and the chart is for use by the East Overshoe Astronomical Society. You might want the following three-line caption:

Asteroid 111 Ate
(As seen in area of M-104)
East Overshoe Astronomical Society

To add these three lines, you would first use "Clear Caption" (assuming, of course, that there is an existing caption.) Next, you would click on "Add to Caption" and enter "Asteroid 111 Ate". You would click the option twice more and enter the remaining two lines. At some point, you would make sure that the caption was turned on (by clicking on "Caption Off", if necessary). When you left the menu, the chart would redraw and the new caption (and any other changes made) would be shown.

In Windows, you also can change the "Layout" of the legend. A "Vertical" layout makes the legend much taller than it is wide; a "Horizontal" layout allows for the opposite case. You can switch the legend between the bottom or top of the chart, and move it to the left, right, or center. By default, Guide uses a vertical layout in the bottom left.

**8e: Measurement Markings (ticks, grids, etc.)**

The Measurement Markings menu provides control over the features that let you measure positions and sizes in Guide. You can reach it at



any point with the Ctrl-T hotkey. When first entered, the menu looks like this:

```
Ticks on
Grids off
Side Labels off
Hatches off
Ecliptic on
Horizon on
Gal Equator on
Telrad off
No aperture shown
```

The first four items are called mensuration (measuring) marks. All four provide measurement of right ascension and declination, just as grids on terrestrial maps provide measurement of latitude and longitude. All four toggle to ON or OFF. By default, ticks are left ON. These are the cross-like white lines on the chart showing where lines of RA and declination cross. "Hatches" are small marks on the side of the chart indicating RA/dec intervals; "side labels" are similar, except that they label the mark with the RA or dec of that position. A little use of all four markings will quickly make their natures apparent.

Each of the four can be toggled on or off. When you turn one on, you will see a Spacing Menu for that option. This menu will look like this:

```
* Automatic spacing
   declin   right asc
    1'         2s
 *  2'         5s
    5'      * 10s
   10'        30s
   20'         1m
   30'         2m
    1          5m
    2         10m
    5         30m
   10          1h
   30          2h
Epoch: J2000.0
[Equ]  Ecl  Alt  Gal
```

The currently set spacings in declination and right ascension will have asterisks (in DOS) or check marks (in Windows) beside them. This menu lets you adjust the spacing and epoch of the marking you just turned on.

By default, the menu will show "Automatic Spacing" checked. This

means that Guide will set the correct spacing based on the amount of area covered by a given chart. It will use a small spacing for small fields of view and a larger spacing for large fields. You will probably be quite content to leave automatic spacing on for some time; eventually, you may run into a case where you would like to override Guide's judgment. If so, click on the spacing desired in each column, and automatic spacing will be turned off.

Similarly, by default, the marking will be shown in the J2000.0 epoch. Click on the Epoch line, however, and you will be prompted to enter the new epoch for this marking. The fact that different markings can use different epochs allows you to, for example, use a J2000.0 grid with B1950.0 ticks.

Also, by default, all markings are in equatorial coordinates (that is, they define spacings in RA/dec). But you do have the option of selecting ecliptic, alt/az (horizon), or galactic coordinates instead.

The next four items are simple toggles, with no submenus involved. Clicking on the Ecliptic, Horizon, Galactic Equator, and Telrad menu items toggles the display of each corresponding item.

The final option in this menu is "No Aperture Shown". The purpose of the aperture ring marking is to put a circle of known size at the center of the screen. Why would you want to do this? Suppose you're using a telescope. You know it has a 1.5 degree field of view. You would like to know what that area looks like on the chart.

You would click on this menu option, and would be prompted to enter the aperture size. You would type 1.5, hit enter, and see a circle, 1.5 degrees across, drawn at the center of the screen. As you zoom in, the circle gets bigger; as you zoom out, it shrinks. The menu option now reads "Aperture 1.5"; click on it again, and the chart is redrawn without the aperture ring and the menu item goes back to "No Aperture Shown".

You can also enter 15' for a 15 arcminute circle, or 45.3" for a 45.3 arcsecond circle.

The colors of all markings (except the Telrad, which is always red) can be changed. In Windows, a small box showing the current color is shown next to the menu option for each marking; you can click on that box to change the color for that marking. In DOS, things are (regrettably) more complex. For grids, ticks, side labels, and hatches, you must toggle that item ON, and the color will be shown in the menu and can be changed. But the colors of the horizon, ecliptic, and galactic equator are changed in the Colors menu, described on page 35.

## 8f: Background dialog



The Background dialog (accessed from within the Display menu) allows you to modify the usual "white stars on a black background" appearance of the screen in Guide. It offers five different types of background settings: "normal colors", "chart mode", "red mode", "flashlight mode", and "realistic".

"Normal Colors" is the default; the background is always black, and printouts are always in black and white (even with color printers).

"Chart Mode" switches to a white background. This was added to allow support for color printing in Windows. If you have a color printer, you can switch to Chart Mode, set colors to match what you want to see printed, and then do a printout. It would be very clumsy to set up colors if you didn't have a way to turn the screen background to white.

While the original reason for adding Chart Mode was solely for color printing, it has turned out to have other uses, and some people prefer it to "normal" mode.

"Red mode" switches to a black background with red markings. It's the preferred mode for operating at night, since red light doesn't do quite as much harm to night vision.

"Flashlight mode" is a sort of inverted version of red mode. In flashlight mode, the background is red, and markings are black. The result is an extremely bright screen, sometimes useful in finding dropped eyepieces and such. You switch to flashlight mode, find the missing object, and switch back to red mode.

"Realistic mode" shows a bright blue sky in the daytime and a dark black background at night. Between sunset and astronomical twilight (the point where the sun is 18 degrees below the horizon), shades of blue denote the progress of twilight. The advantage of this mode is largely that it gives you some hint as to the visibility of a particular event; if you set Guide to show, for example, a lunar occultation, and the background turns bright blue, you can reasonably expect not to see that event.

Finally, there are two check-boxes for "Show Ground" and "Horizon Objects". The first causes the "ground" to be shown in a solid color. Again, this can be useful for determining if an event is visible; if you turn "Show Ground" on, and the event in question is in the "ground" area, you know you won't be able to see it.

With "Horizon Objects" turned on, Guide displays a few objects at the horizon such as trees, houses, cars, streetlights, and so forth. This can provide a certain sense of scale. It's also possible to rearrange these objects and add new ones; see the instructions in the files HORIZON.DAT and OBJECTS.DAT for details. A few people have done this in order to get a "horizon" that matches their actual observing

site. This helps in planning observations (you can get a better idea when the moon will rise from behind a certain hill) and in orienting yourself properly. (Unfortunately, figuring out the azimuth to the objects in question can be a bit of a challenge. You can use a compass, but you can also observe a star pass over the object at a given time, then use Guide to determine the altitude/azimuth of the star at that time.)

By default, the background is white in Chart mode and black in Normal Color mode, and the ground is a brownish-red color. However, three buttons are provided in the Windows dialog box to adjust this. Each is a blank rectangle showing the color in question; click on one, and you get a color selection box.

## 9: SETTINGS MENU

The Settings menu lets you set such details as your position on the earth (latitude/longitude and altitude), epoch, printer, and so forth. It can be reached at any point with the Alt-S hotkey.

When you first enter it, the Settings menu will look like this:

```
Location
Time Menu
Level 3: 45 degrees
Set Colors menu  (DOS only)
Scope control
Level      (Windows only)
Language
Margins menu (Windows only)
GRS longitude=62
RA/dec format
TLE=bright.tle
Projection
Video Mode  (DOS only)
Toolbar    (Windows only)
```

The Location dialog lets you select your observing viewpoint, so you can get data based on your actual position on the earth. Its use is described on page 38.

"Time Menu", surprisingly enough, puts you into the Time menu. This menu lets you reset the time Guide uses for calculating planet positions, rise/set times, and where the zenith is (for use when ZENITH is up). Its full use is described on page 50. You can reach the Time menu at any point by hitting Alt-T.

The next item gives you some control over the field of view shown at a given level. Let's say you're at level 9, where the field of view is normally 30 arcminutes. Let's suppose your personal preference would be for a slightly smaller field of view, of about 24 arcminutes.



You could go to level 9 and click on this menu item. You would be asked to "Enter new level size:" You would enter 24' (or .4, as in .4 degrees, or 1440", as in 24 times 60 arcseconds), and the size of level 9 would henceforth be 24', not the default 30'. You can also reach this item at any time in Guide with the F6 hotkey.

Alternatively, if you just want a simple way to get fields of view other than those provided with Guide, you may wish to use the Fixed Levels option in the Extras menu, described on page 62.

"Set Colors Menu" exists only in the DOS software. It allows you to change the colors used for labelling stars (the text associated with Bayer (Greek-letter), Flamsteed, SAO, and PPM numbers) and the colors for the ecliptic, galactic equator, and horizon. In the Windows software, the colors for star labels are handled within the Star Display menu (see p. 22) and the colors of the ecliptic, galactic equator, and horizon are handled within the Measurement markings dialog (see p. 30).

The Telescope menu is useful if you have an LX-200, Ultima 2000, or Sky Commander connected via serial port to your computer, or if you are using the Mel Bartels stepper motor system. This menu is described in the Telescope Control chapter, on page 44.

In Windows, the "Level" option brings up a dialog box with 20 buttons. Click on one, and Guide will switch to that zoom level. You can also get to this option by clicking on the Level shown in the legend area, in both DOS and Windows.

The Language submenu lists (at present) eight languages: English, French, German, Spanish, Italian, Dutch, Japanese, and Russian. Click on one, and Guide will switch to that language.

Be aware that in each case (except for German and Italian), the translation is not necessarily a total one. In particular, Dutch and Japanese are "works in progress"; a great deal of text has been translated, but much remains. (You may find updated versions on the Web site from time to time.)

The software has been created to allow for the possibility of additional languages; there have already been suggestions for Portuguese and Chinese versions. If any further languages are added, the files will be made available on the Project Pluto WWW site (http://www.projectpluto.com). If you're interested in adding your own language, the text in \WEBSITE\XLATE.HTM on the CD-ROM describes this process.

In DOS, the Margins menu appears under the Printer Setup menu, described on page 48. In Windows, the same option appears under the Settings menu; it actually operates in the same manner as the DOS version. Only the way in which it is reached is different.

The "GRS longitude=62" is used to reset the longitude on Jupiter of the Great Red Spot. As with any other cloud, the GRS is not a fixed object; for example, in mid-1996, the GRS was at about longitude 52. In mid-1998, the GRS had moved to 62 degrees.

The value you enter for the GRS longitude is used in two places. First, when you zoom in on Jupiter, the GRS is placed on the map according to this value. That means you can use expect to see the GRS through your telescope at the same place it appears on the screen. Second, when you click for "more info" on Jupiter, or create a list of GRS transits in the Tables Menu (see page 56), Guide will use the GRS longitude you've entered in its calculations.

Up-to-date values for the GRS longitude can be found in some astronomy magazines, and on the Project Pluto WWW page.

Clicking on the "RA/dec Format" option brings up a dialog box that provides almost complete control over how RA/dec coordinates are shown in Guide. First, one can choose among hours/degrees, decimal minutes, or decimal seconds; decide if leading zeroes should be shown in positions; and choose if declinations should begin with "+/-" or "N/S". Also, you can select the epoch in which positions are to be shown. Although it is called the "RA/dec Format" dialog, it does also contain controls over how latitude/longitude values are shown, and a switch between metric and "traditional" units (inches, miles, etc.) The choices you make here will be used throughout Guide.

The "TLE=" option lets you select a new file of orbital elements for artificial satellites. Artificial satellite elements are almost always provided in files called "Two-Line Elements", or "TLEs"; these files usually have a .TLE extension.

Guide comes with three .TLE files: BRIGHT.TLE, containing data for about 170 of the brightest satellites (those that can reach magnitude 4), GEO.TLE, containing many objects in geosynchronous orbit (or close to such orbits), and IRIDIUM.TLE, containing about 60 of the Iridium communication satellites. By default, Guide uses the BRIGHT.TLE file when plotting satellites on charts, animating them, and in the "Go to Satellite" option.

You may wish to switch to a different .TLE file, for several reasons. Some .TLE files will provide data for more satellites, or other classes of satellites (much as GEO.TLE and IRIDIUM.TLE do). Also, you really need to get updated files quite often. Satellite motion is not entirely predictable; satellites maneuver (using thruster rockets), new satellites are launched, and the way in which atmospheric drag works can't be predicted very far in advance. In fact, the three .TLEs provided with Guide will already be somewhat out of date by the time you get this CD.

You can get new .TLE files from several sites on the Internet. The following site:

`http://www.fc.net/~mikem/tle.html`

is recommended, since it has up-to-date elements for many different classes of satellites, and because many of the element sets have the magnitude data Guide uses in filtering out dim objects. NASA and other government agencies also maintain element sets.

Once you have a .TLE file, click on this option and select that file. Guide will then simply switch to use of this file for all satellite data.

The Projections submenu offers four possible chart projections: stereographic (the default), orthographic, gnomonic, and equidistant. Each serves a different purpose.

The stereographic projection preserves the shapes of objects quite well, no matter how large an area is being shown. If you go to Level 1 (180 degree field of view), the other projections will show very distorted constellations near the edge of the chart. Stereographic will result in scale changes near the edge (the objects at the edge will look unnaturally large), but their shapes will be okay. It is for this reason that the stereographic projection is used for "all sky" charts in the center of many astronomy magazines.

The orthographic projection is really best suited for terrestrial charts, not celestial ones; when used for terrestrial maps, one gets an "Earth-from-space" sort of view. You may want to use it when displaying eclipse/occultation paths on the Earth.

The gnomonic projection involves horrible distortion at large fields of view. However, it shows great-circle routes as straight lines. It is therefore useful for meteor observers; draw the paths of meteors on this chart, and they will appear as straight lines emerging from a single point (the radiant).

The equidistant projection is mostly used for terrestrial charts; in such a chart, you can directly measure distances and azimuths from the center of the chart. (Short-wave radio users sometimes find this to be helpful.)

In Windows, the video mode is a system-wide function, set in the Control Panel. In DOS, though, you have to specify the video mode; you do that with the Video Mode option. It lists the six video modes known to DOS Guide; click on one to select it. See page 4 for more information about this.

The Toolbar option lets you choose which functions appear in the toolbar; you can also simply turn the toolbar on or off. When you select it, the Toolbar dialog will show a list box of all functions that can, potentially, appear on the toolbar. You can highlight

a range of them using the mouse, and then select "On" or "Off" to turn all highlighted items on or off. You can also just doubleclick an option to toggle it. You can use the "Show Toolbar" checkbox to suppress display of the toolbar; and finally, you can click OK to confirm your changes or Cancel to reject them.

By default, Guide shows a "reasonable" sample of functions on the toolbar. Four buttons are provided for the most commonly used zoom levels (1, 4, 7, and 10); buttons are provided to print, to go to a planet, to find a point on the horizon, to go into the Time Menu, to go to a "full horizon" view (180 degrees wide centered at the zenith), to use the "data shown" dialog (described on page 24), and to use the Animation dialog (page 52). However, Guide users are an extremely diverse group; it's safe to assume that almost everyone will have a different set of "most commonly used functions", and therefore, a different toolbar.

## 9a: Location dialog

The Location dialog provides several controls for selecting your point of view on the earth (or on other planets and satellites). When you start it up, you will see the following settings:

```
Earth
Longitude:  W 69.900
Latitude:   N 44.010
Altitude:   100m
[ ] Use geocentric position
 Humidity: 20%
 Temperature: 20 C
 Pressure: 760 mm Hg
```

The very first item tells you that you are looking at the sky as seen from the Earth. If you click on it, you will get a long list of the Solar System objects Guide knows about. You can select one, and thereafter, all planets, moons, and so on will be drawn from that planet (or satellite). Thus, you can see such things as what Jupiter and its moons look like from one of Jupiter's moons, or what the Earth looks like from the Moon or other planets. (The view of the inner moons of Saturn as viewed from Japetus is particularly recommended.) It's not particularly useful, since most Guide users are unable to travel outside Earth and near-Earth orbits. But it can be very interesting and educational. You can also reach this option by hitting the Backspace key.

The next two items are straightforward enough. They describe the latitude and longitude of Bowdoinham, Maine, corporate headquarters for Project Pluto. However, they probably do not describe your latitude and longitude. To change them, click on them. You'll be prompted to type in your own latitude or longitude. You can find this on most maps. You need not be nit-pickingly precise about this. Guide



uses your place on the earth to calculate rise and set times and to get better accuracy on planetary positions. (For example, a solar eclipse visible on one part of the earth may not be visible at another, because the moon isn't exactly in the same spot in the sky.) An accuracy to a degree (meaning about 111 kilometers or 70 miles) will get rise and set times to within about four minutes. But if you want to get good positions for artificial satellites, or times for eclipses and occultations, you will want an accuracy of at least one kilometer.

Also, be aware that systems of latitude and longitude are defined for other planets. For example, the center of the visible side of the moon (as seen from Earth) is defined to be at latitude 0, longitude 0. If you select "Luna" as your home planet, and set those values, the Earth will be shown very near the zenith. (It wanders a bit around that point, due to librations, as described on page 19.)

The next item, "Alt 100 meters", tells you that your point of view is 100 meters above sea level. Once again, you need usually be only approximately correct here.

Clicking on the "Use geocentric position" causes Guide to ignore the lat/lon/altitude values; instead, your viewpoint will be from the center of the earth (or whatever home planet you have selected).

The final three values only have meaning if your "home planet" is Earth and the "geocentric" option is not selected (i.e., you are observing from the surface of the earth). In that case, the temperature and pressure data are used to compute refraction, the bending of light as it passes through the earth's atmosphere. All three values are used in computing the limiting visual magnitude in Quick Info (see page 20).

## 9b: Inversion Menu

The Inversion Menu (in the Windows software, Inversion Dialog) provides a simple way to flip Guide's charts to match the view as seen through your telescope. It can be reached by clicking on the compass symbol in the legend, or with the Alt-I hotkey, or through the Display menu. It shows the following options:

```
* Chart uninverted
  Chart inverted
  Mirror image E/W
  Mirror image N/S

  Rotation 0.0

* RA/dec (north at top)
  Alt/az (zenith up)
  Ecliptic north up
  Galactic north up
```

The first four radio buttons let you flip the chart top to bottom, left to right, or both.

"Chart uninverted" tells you that the chart is oriented the way an unaided eye would see it. If you looked through a telescope, however, you might see something different. Since telescopes use mirrors, you might see a mirror image. They also use lenses, which sometimes spin the image 180 degrees. There are four common orientations: uninverted (the image is not rotated or flipped); inverted (the image is rotated 180 degrees); mirrored east/west (east and west are reversed); and mirrored north/south (north and south are reversed).

For example, most refractors invert the image totally. So do Cassegrain telescopes, including the popular "SCT" (Schmidt-Cassegrain) telescopes. Coude telescopes will invert only on one axis.

The next line states "Rotation 0"; you can use this to add any arbitrary rotation you want. Some people with unusual telescopes find it useful to, say, add a final "spin" of 20 degrees to their charts.

The next item tells you that North is up (i.e., at the top of the screen). So what? Isn't North always up on a chart? Well, not quite.

What Guide is telling you is that celestial North is at the top of the chart, the direction to the North Pole. This is the way most star atlases are printed. The problem is that as the earth turns, the sky seems to turn. Thus, the Big Dipper, which seems to be "right side up" when it's close to the northern horizon, looks "upside down" when you see it high in the sky. You would usually turn a paper star chart until it looks correct. Also, if you have the "show ground" or "horizon objects" options set in the Background dialog, these may appear tilted.

If you select "alt/az (zenith up)", the chart will rotate to show the zenith (point directly overhead) at the top of the chart. If you've entered your latitude and longitude correctly, and if the clock is set to the right time and time zone, the chart will now appear "right side up", and will match what you see in the sky. If you have the horizon turned on, and it happens to be in the field of view, it will now be drawn straight across the screen, instead of at an angle. Since Guide is still centered on the same point in the sky, the effect will be to take the chart and rotate it, possibly until it is upside down.

Having the zenith at the top of the chart is particularly useful if you have an "altitude/azimuth" type of telescope mounting, such as a Dobsonian. It is also useful for making charts showing a large part of the sky (i.e., low level numbers) for naked eye observing.

The last two radio buttons, "Ecliptic north up" and "Galactic north up", are not nearly as useful. But sometimes, people do want charts



aligned with these systems.

## 10: OVERLAYS MENU

The Overlay menu lets you create and edit your own overlays, showing lines, circles, and text, on top of the charts. It also provides a few example overlays, showing constellation borders, names, and outlines, plus the pages in the AAVSO atlas and the plates in the Palomar Sky Survey.

You can use your own overlays to (for example) show areas you want to view in an observing session, or to label some objects or points of interest, or to add comparison magnitudes to a chart, or for any other use. When you first enter the Overlay menu, it will look like this:

```
Constellation lines
Low range 9.0
High range 91
Toggle overlay on/off
Create new overlay
Delete an overlay
Add Lines
Add Text
Add Circles
Color =
User Object Menu
```

The top line tells you that you're currently "editing" the constellation lines overlay. The next two lines tell you that this overlay is shown when the field of view is from 9 to 91 degrees across. (When you're looking at a larger field, such as a full hemisphere, the constellation lines get crowded and in the way. Below 9 degrees, they cease to tell you much of anything.)

You can select a different overlay by clicking on the top line; Guide will show all the overlays it knows about, and you select one. The top three lines of the Overlays menu will change to reflect your new choice.

You can also reset the low and high range values by clicking on those menu lines. You'll be prompted to enter a new range value. As with any angular input, you can add a single quote (') to indicate arcminutes, or a double (") for arcseconds.

The next line, "Toggle overlay on/off", brings up the same list of all overlays. Those currently turned on will have check marks next to them. You can go through the menu and toggle some overlays on or off. When you exit the menu, the screen will be redrawn with the new overlays turned on or off. This is the menu you use to turn constellation markings on or off. You can't actually edit those overlays, but you can control their display from this menu.

"Create new overlay", logically enough, will ask for the name of the new overlay, then reset the top line to match. By default, the new overlay will be turned on and ready for editing.

"Delete an overlay" provides the list of all overlays. Select one, and you'll be asked to confirm that you wish to delete it. Be aware that some overlays (planet trails, constellation borders, etc.) can't be deleted.

The remaining lines are all concerned with adding objects to editable overlays. Click on "Color =", and you'll get a list of possible colors for the objects you add to the overlay. The three lines "Add Text", "Add Lines", "Add Circles", select the type of object you add to the overlay. When you select one, a check mark will appear next to that item.

Also, in the DOS software, when you select an "Add..." object, the mouse cursor will change when in the chart area; a "T", "L", or circle will appear to remind you that the right mouse button can now be used to add such objects to the screen.

In the DOS software, the "add text" mode will add the option of selecting from nine possible alignments for the text. The default is centered text.

If you've selected "Add Text", you can then click on the chart with the right mouse button. Instead of getting some data about the object you clicked on, you'll be prompted to enter some text. This text will be added to the overlay, placed on the point where you clicked.

If you've selected "Add Line", you can click on the chart with the right mouse button and drag a line, in the same way you would normally measure the distance and position angle between two points. When you let go of the mouse button, the line will be drawn in the current overlay color, and added to the current overlay.

"Add Circle" works almost identically to "Add Line", except that instead of a line appearing between the two points, a circle is drawn centered on the first point. Also, in the DOS software, if you're drawing circles, the Overlay Menu will add an item reading "Circles Dragged". This item toggles between the default behavior (the size of the circle depends on how far you drag the mouse) and a fixed size for all circles.

Suppose, for example, that you want all circles to have a radius of 32 arcminutes (which happens to match the field of view of your scope and eyepiece). You would click on "Circles Dragged", and would be prompted to enter the circle size. Type 32', hit Enter, and any circles you added would be that size.



So far, we have not addressed the issue of editing objects already in an overlay. This is actually simple to do, and can be done at any point in Guide (not just from the Overlays menu). All you need do is to click on the object with the right mouse button, as you would to get information about any object.

However, instead of getting two buttons, "OK" and "More Info", you will have three buttons: an "OK", plus buttons for changing the object color or deleting the object.

## 11: USER OBJECT MENU

The User Object menu provides a handy way to keep a list of the objects you're interested in that don't appear in the "Go To Object" set of menus. You can reach it from the Overlays menu, or with the F5 hotkey.

When you enter this menu, it looks like this:

```
Add an object
Delete an object
Go to an object
Save to Sky Comm
Output to File
```

All items except "add an object" and "esc to prev menu" are grayed out, since there are no objects yet to be deleted, gone to, saved to a Sky Commander, or output to a file.

If you center on an object of interest, then click on "add an object", you'll be prompted to enter a name for the object (such as "Barnard's Star", "possible variable", etc.) The object will be added to the list and the grayed out menu items will no longer be grayed out.

If you select "Delete an object" or "Go to an object", the complete list of entered objects will be shown, and you will select one. Do so, and either that object will be removed from the list (after you confirm that action), or Guide will simply recenter on that object.

"Save to Sky Comm" will remain grayed out until you have gone into the Telescope Control menu (see page 44) and told Guide that you have a Sky Commander, and also on which port it is installed. If you've done so, you can click on this menu item to update the Sky Commander's user library.

When you do so, Guide will take the list of objects you have created and provide their locations to the Sky Commander. You can then take the Sky Commander into the field and find those objects.

If you are going to do this, it can be useful to have a list of

the objects, complete with the numbers that the Sky Commander has assigned to them. To do this, you can click on "Output to File". This will ask for the file name. If you select PRN or LPT1, the list will be printed. Otherwise, you can store the list in an ASCII file for further use.

## 12: TELESCOPE CONTROL MENU

Those with an LX-200 or Ultima 2000 telescope, or a Sky Commander encoder system connected to their computer can control the telescope from Guide, using the Telescope menu item inside the Settings menu. You can also reach the Telescope menu at any point in Guide with the F4 hotkey.

Those with encoder-based systems other than the Sky Commander will have to perform an alignment step, and should consult the next chapter.

When you first enter the Telescope menu, it will look like this:

```
* No scope available
  COM1
  COM2
  COM3
  COM4
LX-200
Sky Commander
Ultima 2000
Alt/Az
```

In the DOS version, the "Sky Commander", "Alt/Az", and "Ultima 2000" options are not shown, and the "LX-200" option is a toggle; click on it, and it switches to "Sky Commander".

The two "slew" options are grayed out, and will stay that way as long as no telescope is available. The line "LX-200" is a toggle; click on it, and you switch to "Sky Commander".

A description of how to connect a computer to the LX-200 is given on page 87 of the LX-200 instruction manual. You should determine to which COM port the LX-200 is attached, and pick the corresponding menu item in the LX-200 menu. If you don't know which port is used, click on each in order and try to do a slew. If you've selected the wrong port, Guide will pause for about fifteen seconds, then report its failure.

The LX-200, Ultima 2000, or Sky Commander can be set up in their usual manner (alignment, etc). Guide enters the picture when you are ready to find or identify objects. Once you have used the Telescope dialog to tell Guide what sort of telescope you have and which serial port it uses, two items will be added to the main menu: "Slew Scope" and "Slew Guide".



"Slew Scope" is for aiming the telescope (and doesn't work with the Sky Commander; since the Sky Commander lacks motors, Guide can't slew the telescope). If you have found and clicked on a location in Guide, hitting "Slew Scope" will slew the telescope to that location. You can also do this by hitting F11 or Ctrl-F1 at any point in Guide.

The "Slew Guide" option will cause Guide to find out where the telescope is pointed. Guide will then pan to that location, leaving the telescope where it is. You can also do this by hitting F12 or Ctrl-F2 at any point in Guide. This option works with all three systems.

Also, if you have toggled to the Sky Commander and have selected its port, you can copy a list of positions from Guide to the Sky Commander. You can then take the Sky Commander into the field and observe those objects. This is further described in the section on the User Object menu, on page 43.

The Windows version adds a button labelled "Alt/Az"; this corresponds to a stepper-motor system designed by Mel Bartels and used by several Dobsonian owners. The advantages of the Alt/Az system are simplicity, good precision, and very low cost. The system consists of stepper motors added to the altitude and azimuth axes, and driven by the PC. All of the "intelligence" for alignment, etc. is in the Alt/Az software, making for very minimal hardware requirements.

If you have an interest in connecting your own, customized computer-controlled telescope to Guide, you may wish to check the file \COMPRESS\XTROL.DOC on the CD-ROM. It contains some data on how communication with LX-200 and ALTAZ systems is done by Guide.

### 12a: Encoder-based systems

Handling encoders in Guide is a slightly different process. Encoders allow a computer to find the telescope position; they don't provide a means of physically moving the telescope, the way an LX-200 can. So the control and alignment procedures are quite different.

Guide provides support for the Tangent Instruments class of encoders. This includes encoders supplied by Lumicon, JMI, Orion Sky Wizard, Ouranos, Astro-Master, MicroGuider, and most others. For lack of a better term, this entire class of encoders will be referred to as "JMI-MG III".

Only the Magellan and Sky Commander encoders are not included in this class. (The Sky Commander is handled separately within Guide, as described in the previous chapter.)

To use your JMI-MG III compatible encoders, hook up the interface to the computer, start Guide, and click on "Settings... Telescope

Control". Select the serial port used for the encoders; this is usually COM2, but it may be COM1 on some laptops. And in some odd cases, it may be COM3 or COM4.

Also, select the "JMI-MG III" radio button, and enter the scope resolution in the boxes at the bottom of the dialog. Click OK. After a short pause, Guide will confirm that it has received an '82 (R)' from the encoders. (If it gets any other value, then Guide has been unable to set the encoder resolution correctly. Check the encoder connections and make sure the COM port has been set up correctly.)

Guide will add a "Scope Pad" option to the menu when you do this. Click on it, and you'll get a small dialog box with assorted scope control commands.

The next step is to add at least two alignment stars. To add an alignment star, you first find it in Guide (by panning, or using "Go To..." commands, or whatever you wish) and clicking on it with the right mouse button. When you get the short dialog box describing the star, click OK.

Next, point the telescope at this alignment star. Once you have it centered, click "Add Alignment Star" in the scope pad. Guide will add that point in the sky to its alignment database.

When you add the first star, there will be an additional step: you'll have to tell Guide if you have an "equatorial reading hour angle", an alt/az, an alt/az scope on an equatorial platform, or an equatorial reading RA. The alt/az options are straightforward enough, but the equatorial options require some explanation. It seems that encoders on equatorial scopes are about evenly divided between two mounting methods. Some people use one encoder to measure the hour angle at which a telescope is pointed; with the drive motor on, this encoder reads a changing value as the scope moves. Other people, though, will use one encoder to measure the RA at which the telescope is pointed. In such a case, the drive motor doesn't force the encoder to move.

Unfortunately, Guide has no way to determine which system you're using. So when you add the first alignment star, it will ask you for this information.

After you have added at least two alignment stars, you can actually get some pointing feedback from the telescope. Click on "Slew Telescope". Guide will read the encoders at 1/2 second intervals, putting a red circle on the screen to indicate where the scope is pointed. If the scope is pointed off-screen, Guide will force a redraw and then put the red circle on the screen. This is useful in aiming the telescope; you set a wide field of view, click "Slew Telescope", and push the telescope until the indicator circles the target.

Once you're done with this, clicking on "Slew Telescope" again will



shut off the red-circle updates.

Alternatively, clicking on "Slew Guide" will cause it to read the encoders once, resulting in the chart being redrawn at the current telescope position.

Adding still more alignment stars can improve pointing accuracy considerably. If you find that the accuracy is poor in a given part of the sky, it's advisable to find a nearby bright star and to add it as another alignment star. This gives Guide an idea as to the amount of error in that part of the sky; it can then compensate accordingly.

At present, there is no command to delete the alignment data; and this is something you'll want to do if you move the scope or shut down the encoders. To clear alignment data, delete the file ALIGN.DAT in the Guide directory.

## 13: PRINTER SETUP AND PRINTING

Within the File menu is the "Printer Setup" menu item. In the Windows software, the standard printer setup menu is used, offering control over orientation, resolution, which printer is used, and so forth.

The DOS software does not use this system; it uses instead the menus described in this chapter. In the DOS software, you can also reach the Printer Setup menu with the Alt-C hotkey. BEFORE YOU DO ANY PRINTOUTS, you must enter this menu and tell Guide a few things about your printer.

The Printer Setup menu, when you first run Guide, will look like this:

```
No printer selected

Portrait
Black stars on white
Margins Menu
Print on PRN
 1 Copy
Add to Queue
Flush Queue
esc to cancel
```

At the very least, you will have to click on the top line (currently reading "No printer selected") to choose a printer. When you click on that line, a list of the printers that Guide can use will be shown. Even if your printer is not on the list, it is almost certain that it can emulate one that is on the list. You can find which one, and how to set your printer to that emulation mode, by looking in the manual for the printer. (You'll notice that you can also "print" to PCX files at 640x480, 800x600, and 1024x768 resolutions; or at larger,

"full-page" resolutions.)

Once you have selected a printer, Guide will find out at what resolution(s) the printer can work. If it supports more than one resolution (such as a "draft" and "final copy" mode), it will list the possibilities and ask you to select one. On some printers, the draft mode can be much faster than the final copy mode, so it can pay to try both.

When you have done this, the "No printer selected" will be replaced by the name of the printer you chose, and the formerly blank line underneath will now list the resolution you chose.

You can click on the printer name at any time to change the printer used. You can also click on the resolution chosen to select a new resolution.

Next, clicking on the "Portrait" line toggles the way in which printouts are made. In Portrait mode, the chart will make the "top" be the short edge; in Landscape mode, it will be on the longer edge.

You will probably never need to toggle the "Black stars on white" to "White stars on black". When you do so, the resulting printout looks like a photographic negative, with white and black reversed. It is, on rare occasions, a useful option; hence, its inclusion in this menu.

By default, there are half-inch margins on all sides. The Margins menu lets you reset these values. For example, in making the cover for this manual, the back cover was printed with the right-hand margin set to 5.8 inches. The front cover was printed with the left-hand margin set to 5.8 inches and the top margin set to 3 inches (to make room for the title). All other margins were left at default values.

Now Guide knows what sort of data to create for your printer, but it still doesn't know where your printer is. This is where the "Print to PRN" comes in. By default, Guide assumes that it can send data to PRN and get a printout. However, you may have your printer hooked up to a different parallel or serial port, or you may want the printout to go to a file. (You would certainly want PCX images, for example, to go to a file.)

When you click on "Print to PRN", Guide will show you your choices. You can select parallel or serial ports or output to a file. If you click on a parallel port, then Guide will know all it needs to know about where to print. If you select a serial port (COM1 or COM2), Guide will want two more pieces of information: the baud rate your printer accepts, and the data parity. You can try a low baud rate first; if that works, you can move up to faster speeds. Most printers expect data sent with no parity bits, but you may have an oddball, so Guide has to ask for your printer's requirements here.



(If you aren't sure what parity the printer expects, try no parity.)

If you select output to a disk file, Guide will ask for the file name. Whatever you select, Guide will change the "Print to PRN" menu item to "PRINT TO" whatever you chose.

If you are running Guide on one machine, but would like to print from another machine, the ability to print to a disk file can be especially useful. Set Guide to print to a disk file (for example, COPELAND.PRI). After "printing", you can copy the disk file to a floppy (or over a network), then print it from the second machine with the DOS command

```
copy copeland.pri prn /b
```

(substituting the name of the file you have created). This command will send the data Guide created when "printing" to the actual printer.

Next, there is an option to set the number of copies made. Normally, you will have no reason to print more than one chart, but should circumstances demand extra copies, you can click here and enter the number of copies to be printed.

The actual act of printing is simple. You can either hit the "Print" option in the File menu, or the F2 hotkey. You can abort printing by hitting escape. If you chose landscape, Guide will print the area visible on the screen plus a little bit of area from the left and right sides. If you chose portrait, Guide will print the area visible on the screen plus a little bit of area from the top and bottom. Guide will first show the word "Drawing..." in the position area. Next, the screen will clear and you will be given information on how the printing is going. Depending on the resolution of your printer and your machine's speed, this part may take as long as several minutes.

If stars come out larger than you want, you can adjust their maximum size by using the Mag Range menu option in the Star Display menu. This happens often on low-resolution printers.

Some Epson-compatible printers will show a slightly "stretched" printout; circles will appear to be slightly oval, about 11% longer on one axis than the other. To fix this, hit the F10 key. You'll be prompted to "Enter rescale:" Enter a value of 1.125. On a few printers, this will actually make the problem worse. If this happens, try again, with a rescale value of .889 (reversing the effect). Fortunately, not many printers require this fix; if yours does, you will need to do this once. Guide will then store the fixed value.

The last two options in the Print menu provide a convenient way to set up a series of printouts, then print them all at once. The method

is simple: you set up the printout in a normal manner, getting the desired area and objects on screen, selecting the printer and the "Print To" line. But instead of hitting "Print", you select "Add to Queue."

Each time you "Add to Queue", Guide will add that area and setup to a list of charts to be printed. It will provide a message such as "1 job in queue", but it won't actually print the chart right away. Eventually, when you have set up all the charts you want to print, you hit "Flush Queue", and Guide will print everything. You can "add to queue" with the Shift-F3 hotkey, and "flush queue" with the Shift-F4 hotkey.

### 13a: Postscript charts

The Extras menu of Guide contains a "Make PostScript File" option. PostScript charts can be imported directly into some desktop publishing packages. Because they are vector, not bitmap, files, they can be more easily edited. Also, people running Guide under DOS and OS/2 sometimes have found that making a PostScript file, then printing it using GhostScript, produces particularly good charts, and can be faster than the usual DOS (or Windows) printing. People with PostScript printers can simply copy the files to their printers to get high-quality output.

To make such a chart, you should first follow the "normal" steps required for printing (setting margins, making sure the right part of the sky is on the chart and that the objects you want are turned on, and so forth). But then, instead of clicking on "Print", use the "Make PostScript File" option in the Extras menu. (Alternatively, you can hit the Alt-P hotkey.) In DOS, you'll be prompted to enter a filename; in Windows, a dialog box will be shown, from which you can select a filename (or enter a new one).

Enter or select a filename, and Guide will write a PostScript file to it.

In part because PostScript has better font technology, charts created using PostScript tend to have the best possible appearance.

## 14: THE TIME MENU

Within the Settings menu is an option labeled "Time Menu" (actually now a dialog box). You can get to the time menu either with this menu option or by hitting Alt-T, or by clicking on the time shown in the legend.

Setting the time in Guide is probably one of the most common things people do, so an immense amount of control is provided in this dialog box.

When you enter the Time Menu, you will see something like the



following. The exact values will depend on what your computer's built-in clock says when you start Guide.

```
++   +   ++++ ++ ++ ++
 8 AUG 1985 12:03:31
--   -   ---- -- -- --
Su Mo Tu We Th Fr Sa
28 29 30 31  1  2  3
 4  5  6  7  8  9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30 31
 1  2  3  4  5  6  7
   Time Zone  EST
  JD 2446282.21078
 Gregorian Calendar
    Current Time
 Jan  Feb  Mar  Apr
 May  Jun  Jul  Aug
 Sep  Oct  Nov  Dec
  OK         Cancel
```

Right at the top, we have Guide's idea of what the time is. By clicking on a button above a figure, you can increment it; for example, each time you click above where the '9' is in 1985, you will go forward by a century. By clicking on a button below a digit, you can decrement it. This is good if you only want to change a few figures a small amount and don't want to reach for the keyboard.

Clicking on the year, hour, minute and second fields on the second line lets you enter those values from the keyboard. For example, if you wanted to go from 1985 to -333, you might want to spare yourself some mouse clicks on the arrows.

When you enter an hour, you can also reset the minutes by entering something like "3:14"; or you can reset the hours, minutes and seconds with something like "3:14:16".

A note on years before 1 AD. There are two conventions for the numbering of such years. Historians do not use a year zero. To them, the year before 1 AD is 1 BC. To astronomers, the year before 1 AD is 0, and the year before that, -1. This makes for a one-year difference: for example, the solar eclipse astronomers tell us happened on 28 Aug -1203, historians will say happened on 28 Aug 1204 BC. Guide sides with the astronomers, recognizes the year 0, and would expect -1203 to be entered in the above instance.

The next few lines provide a calendar for the current month, plus the usual partial calendars for the previous and following months. You can click on the days shown in this calendar, which also provides a pretty simple way to back up or move ahead a month or two.

The "JD..." option lets you both see and reset the Julian Day. The Julian Day system (no relation to the Julian calendar) is in common use by astronomers; it specifies time in terms of days since noon, 1 Jan 4712 BC. Thus, 1 Jan 2000 is JD 2451545.; that is how many days will have elapsed since 1 Jan 4712 BC. As you alter the time, the value shown here will change, and if you click on it, you will be asked to specify the time by Julian Day.

The "Time Zone EST" option lets you tell Guide what time zone you are using. Clicking on it puts you into a dialogue listing the zones in the continental US, both Standard and Summer (Daylight Savings) versions, plus UT (Universal Time). You can also enter your own zone, as a difference in hours between UT and local time. This can be fractional; Guide users in central Australia, for example, must contend with a time difference of 9.5 hours.

By the way, this zone need not match the one used by your computer's clock. If you wish to have Guide show times in UT, even though your PC clock is set to EST, this is not a problem.

The "Gregorian Calendar" option lets you toggle between Julian and Gregorian calendars. The Julian calendar is usually used for all dates before 1582, and in some countries, was used for many years thereafter. It was created by Sosigenes around 44 BC, and contains a slight inaccuracy that resulted in a 10-day error by 1582. At that time, Pope Gregory decreed that the day after 4 October 1582 would be 15 October 1582, getting rid of the accumulated error, and that three leap days would be omitted every four centuries to get rid of future errors. You will probably wish to use Gregorian dates for all dates after 1918 and Julian dates for all those before 1582. For those in between, which calendar was in use varied by country. Britain, and therefore its colonies, used Julian dates until 1752. Japan changed over in 1873. Russia/the USSR changed over in 1918.

Clicking on "Current Time" causes Guide to look at your computer's clock and to use its date and time. You can get the same effect at any point in the program by hitting the F3 key.

Clicking on any of the twelve month keys, logically enough, resets the time to that month.

A further small, but sometimes helpful, point: Hitting Alt-0 (outside the Time Box) will reset the time to midnight UT.

Finally, if you are a keyboard-oriented person, you may find it easier to reset the time using the "Enter Time" feature in the Extras menu (page 61).

## 15: PLANETARY ANIMATION AND EPHEMERIS CREATION



Guide does allow you to watch the planets, asteroids, and comet move in time-lapse animation from the animation menu. You can also use this menu to show the tracks left by an object over time and to dump ephemerides to a file.

You can get to the animation menu via Alt-A at any time. If you are in the main menu, you can simply use the Animation menu option. The animation menu will look like this:

```
rate 1.0 sec
Animation Dialog
Real Time
Clear Trails
Add a Trail
Make Ephemeris
Index Freq 5
Ephemeris Items
```

By default, animation is stopped and the time step is one second, and the "Add a Trail" and "Make Ephemeris" options are grayed.

In Windows, clicking on the Animation Dialog option will bring up a dialog box showing five buttons at the top to "animate backward", "take one step back", "stop animation", "take one step forward", and "animate forward". In DOS, these five buttons appear directly in the menu.

To use animation, zoom and pan the chart area to show the solar system object(s) you want to see animated. Set the animation rate to the desired value. You can use the "Faster" and "Slower" buttons to get step sizes from one second to over a hundred years. You can also click on the step size itself to be prompted to type in the step size. For your first few efforts, you will probably do well to start with a small step size and work your way up.

You can also run animation in "real time" (the objects move according to the actual time, as provided by the computer's built in clock) by clicking on Real Time. Clicking on it again returns you to your previous rate of animation.

Once you have set the desired rate, you can click on the double-arrow "animate forward" button, and solar system objects will start to move. How often they are updated depends on the speed of your machine and the presence of a math coprocessor. You can then click on the central "stop animation" box when done. The remaining arrows allow you to run the process backward, or to take single steps in time forward or backward.

Be aware that because calculating planetary positions is time-consuming (especially on machines without a math chip), Guide may not respond in a lightning-fast manner to mouse clicks when animation is

running. You may need to hold down the mouse button for a little longer than usual when animation is in progress. This is especially true when you're zoomed in far enough to see planets as disks. The math involved in accurate portrayals of planets (showing the correct side of the planet, illuminated properly, with shadows cast by other moons or planets on the object) can be quite time-consuming. In some cases, where you are not particularly interested in the surface details of planets, you may want to turn "bitmap planets" off (see page 27). This will greatly improve performance.

In Windows, the animation dialog will contain four extra radio buttons:

```
(*) RA/dec
( ) Moving
( ) Horizon
( ) Proper motion
```

In RA/dec mode, the default, the center RA/dec of the screen remains unchanged while animation proceeds, so that stars do not move. In DOS, only the "RA/dec" mode is possible, and these four buttons are therefore eliminated.

The use of the remaining buttons is a little complicated, but a few examples will make it quite clear. It's recommended that these three options be used with "Direct to Screen" (see page 22) left unchecked.

First, zoom in on Jupiter at level 12, and set the animation rate to about 15 minutes. Click on Jupiter with the right mouse button (the "get info" button), and click "OK" in the resulting dialog box, much as you normally might.

Now click on the "Moving" (Target) option in the Animation Dialog and start animating. The effect of this option will be immediately obvious: while animating, the moving target you selected (Jupiter) stays at the center of the screen. In RA/dec mode, watching Jupiter's moons in animation can be annoying, because the planet wanders off the screen; but the Moving option forces a "moving target", such as a planet, asteroid, comet, or satellite, to stay at the center of the chart.

One drawback will be immediately apparent: if Jupiter is to stand still, stars have to be redrawn at each step. That takes some computing power, and the results can be somewhat jerky. (This is also true of the remaining two options.) It is just barely acceptable on a 100MHz '486.

To see how the "Horizon" option works, go to a Level 4 (20-degree) field of view. Click on "Go To... Horizon" and select "NE" (move to Northeast horizon). Go to the Inversion Dialog and select Zenith Up.

You will see the horizon as a dark blue line near the bottom of the chart (and/or as a filled-in ground area, or with objects such as trees,



if you have selected those options in the Background dialog). Go back to the Animation Dialog, set a 5-minute stepsize, click on the "Horizon" radio button, and start animating.

As the name suggests, the horizon will now stay fixed while everything else moves (stars rise above the northeast horizon). In general, the idea is that if you go to a particular altitude and azimuth (in this case, about 8 degrees above the horizon and at azimuth=45 degrees), that point stays fixed while stars, planets, and so forth rotate by.

To demonstrate the "Proper Motion" option, click "Go To... Nearby Star", and select Barnard's Star. Zoom down to Level 6 (five-degree field of view). Increase the animation step size to about 8 years/step. Click on the "proper motion" radio button, and start animating.

In this particular field, Barnard's Star is the only one with really large proper motion. You'll see it slowly drift to the north, at about 10 arcseconds/year.

Using this option for wider fields usually requires a much larger step size to get much in the way of visible motion. This is just another way of saying that most stars are quite close to being "fixed".

The remaining items allow you to display the paths of solar system objects, or to create an ephemeris file of positions on your hard disk. The process for adding a trail may take some practice. Let's take an example. Suppose you would like to create a trail showing the motion of Mars starting at 10 Nov 1993, and running for 100 days after that. You need to make sure that the time (in the Time Menu) is set to 10 Nov 1993, and that the animation step size is set for 1 day/step. You must click on Mars with the RIGHT mouse button; this will immediately result in the usual summary of data concerning Mars.

When you click on a solar system object, the Add A Trail and Make Ephemeris options turn to white, indicating that you can make a trail or ephemeris for that object. If you click on a non-solar system object, you can't make a trail or ephemeris, and these two options remain grayed out.

Assuming you have set the time, the time/step, and have clicked on the desired object, you can now click on Add A Trail. You will be asked to "Enter # of steps:" Type 100 and hit Enter. The computer will calculate the position of Mars at one-day intervals (the selected animation step) for 100 steps. It will then display the trail on the screen.

You'll notice that you control the number of positions when you click on Add A Trail and the time step between them by setting the animation step size.

You may wish to put index marks on the trail. These are controlled by the Index Freq menu item. By default, Guide will put an index mark at every fifth step; in the above example, the position of Mars would be marked at five-day intervals. Click on "Index Freq 5", and the index marks are cleared and the menu item changed to "No Index Marks". Click on it again, and you will be asked for the new frequency of index marks.

Guide will automatically save your trails when you exit the program, and will bring them back up when you restart the program. The trails are stored as an overlay, which means you can control their display in the Overlay menu. You can add text, lines, and circles to the trails, select select the fields of view where they can be shown, and remove unwanted objects. This is discussed in detail in the section on user overlays on page 41.

The steps for creating an ephemeris for a solar system object are very similar to those for creating a trail. As before, set the animation step size and current time, and click on the object for which you want an ephemeris. Click on "Make Ephemeris", and enter the number of steps. As before, Guide will pause to calculate positions. When it's done, instead of showing a trail, it will show a table of positions, distances, and (usually) magnitudes for the object. Because this table is part of the help system, you can print it or store it in a file, just as you would any other help topic.

By default, Guide will provide some fairly useful data in the ephemerides, but you may want to provide different details. For example, for an artificial satellite, the alt/az may be of greater interest than the RA/dec; or you may want to list the percent of an object that is illuminated. In such cases, the Ephemeris Items dialog can be very helpful. It contains a set of check-boxes for every item that can be shown in an ephemeris. You can also use it to tell Guide to skip ephemeris lines where the object is below the horizon, and/or it's daylight.

You do have to exert some restraint here. If you enable all of the items that can appear in an ephemeris, the lines will be quite long, and won't print out or display very intelligibly.

## 16: THE TABLES MENU

The Tables menu contains the following options:

```
Lunar data
Lunar phases
Lunar apogee/perigee
Lunar eclipses
Solar eclipses
Current comets
Current asteroids
```



```
Jupiter events
GRS transits
Create star list
```

Each option allows you to make a table of data, which can be viewed on screen, then saved to a file or printed.

Except for the final "Create Star List" option and the "Current asteroids" and "Current comets" options, each item generates a list of events during a particular time span. You set Guide's date and time to the start of the time span, click on the menu option, and tell Guide for how long a span you want data.

For example, suppose you want lunar rise/set and libration data for October 1997. You would enter the Time Menu, set the date and time to be 1 Oct 1997, and select OK. Then you would enter the Tables Menu, select the top option, and tell Guide you wanted data for 31 days. Guide would pause briefly, then show you a table with data for that time span. The window containing the data would include "Save to File" and "Print" options.

The "Jupiter events" option will make a list of Jupiter's satellite events, the occultations, shadows, eclipses, and transits that are visible with small telescopes. It is essentially the sort of list Guide shows in "More Info" for Jupiter (see page 19), except that you can set the time span instead of settling for a fixed seven days.

The "GRS transits" option will make lists of times when the Great Red Spot is best placed for viewing. The tables will be reasonably accurate as they stand; but if you really want to get some added precision, you may want to update the GRS longitude from time to time, as described on page 36.

The "Current asteroids" and "current comets" options are extensions of the data shown in Quick Info. Quick Info always shows currently visible asteroids down to magnitude 11, and comets to mag 15. But if you use these two options from the Tables Menu, Guide will ask for a limiting magnitude. So you get a little more control over how much data you receive.

The final option, Create Star List, is used to generate a list of stars, down to a specific limiting magnitude, that cover the area currently shown on the screen. To use this option, first find the area of interest, and set the field size to cover it. Select this menu option. This will prompt you to enter a limiting magnitude. (If you enter, say, 20, you'll get all the stars in the area.)

Guide will pause to gather data for stars in the area you've requested that are brighter than the limiting magnitude you entered. When it's done, it will show you the list of stars on the screen. For each star, the GSC number, RA, dec, and magnitude will be listed.

If the data comes from the Tycho or Hipparcos catalog, numbers for that star from several catalogs may be shown: the HD, PPM, Yale, SAO, and Hipparcos numbers can be listed. If the data comes from the GSC, then you get different data: an "object type code" (0 for stars, 3 for "non-stars") and a plate identifier.

The format of the RA and dec is the currently selected one (see pages 16 and 36), as is the epoch. Once the list is generated, you can save it to an ASCII file or print it much as you would any other help topic.

A few warnings about the list are in order. First, if a star appears in both Tycho/Hipparcos and in the GSC, it will have data from both catalogs. Sometimes, this is useful (which is why the second line is not removed), but in most cases, one will want to pay attention to the Tycho data and ignore the GSC data. Second, you should be aware that if a GSC star appears on more than one plate in the GSC, it will appear more than once in the list. (Multiple appearances are common, since the plates overlap quite a bit.)

## 17: THE EXTRAS MENU

The Extras menu offers the following options:

```
RealSky image
Add DSS image
Clear RealSky images
RealSky shutoff
----------------
Get A1.0 data
Edit Comet data
Add MPC comets/asteroids
Enter Time
Fixed levels
Line of variation
Toggle user datasets
Make PostScript file
Make .BMP File
----------------
Find conjunction
Show eclipse
```

The first four options allow one to extract and view data from the RealSky and Digital Sky Survey CD-ROMs. These are compressed scans of the original Palomar Sky Survey. The DSS consumes over 100 CD-ROMs; RealSky only consumes 9, but the image quality is not quite as good. Both are available through the Astronomical Society of the Pacific; contact data is on page 76.

In what follows, "RealSky" will be used to refer to both RealSky and the DSS. From the viewpoint of Guide, they are the same.



Using RealSky in Guide is really pretty simple. First, center Guide on the object for which you wish to have an image, and click on "RealSky image". Guide will ask for the size of the image you want, in arcminutes; type it in and hit Enter.

Guide will pass the information on to the GET_DSS program. GET_DSS will ask for a particular CD-ROM, by number. Extract the Guide CD, and insert the correct RealSky/DSS CD, and hit Enter.

With the 32-bit software (for Windows 95, 98, and NT), GET_DSS will provide some extra options. You can choose from RealSky North, RealSky South, or DSS (keeping in mind that usually only one of the RealSky options will work; the other will result in a "No plate covers this area" message). Often, a given area was covered by more than one photographic plate; when that happens, GET_DSS will give you a choice of plates. Also, you can get a "sampled" image. Most people will use the default sampling of 1 (use every pixel); but this can result in truly enormous files. Changing the sampling results in smaller files that usually draw somewhat more quickly.

Once GET_DSS has extracted all the data, it will ask you to reinsert the Guide CD-ROM. Do so, and click OK.

The GET_DSS program will shut down, control will return to Guide, and you will see your image, properly oriented on the screen. You can zoom in and out on it, and print it.

A few hints about RealSky display: When you switch to Chart Mode (p. 33), the image is switched to be a negative. When you're entering a size, you can enter a rectangular size such as "30x20" to get an image that is 30 arcminutes wide, 20 high. And the images are not aligned perfectly in the north/south direction; the tilt is usually pretty small, but grows toward Polaris and toward the edge of a plate.

Also, be aware that GET_DSS is a memory-hungry program. You may find that really large regions cannot be extracted.

The second, "Add DSS Image", option can be used to import a DSS image downloaded from the Internet. There are currently at least four Web sites one can visit and get DSS images from:

`http://stdatu.stsci.edu/dss`
(Space Telescope Science Institute)
`http://arch-http.hq.eso.org/cgi-bin/dss`
(European Southern Observatory)
`http://cadcwww.dao.nrc.ca/dss`
(Canadian Astronomy Data Centre)
`http://dss.mtk.nao.ac.jp/`
(National Astronomical Observatory of Japan)

You can visit these sites and get a DSS image in FITS format. If you do that, you can then click on the "Add DSS Image" option, and specify the name of the image you have just downloaded. Guide will then display it. It will be just as if you extracted the data from the CD; only the method of importing the image is different.

Eventually, after accumulating some images, you will want to clear them. To do so, use the "Clear RealSky Images" option. Guide will ask you to confirm that you really want to delete the images, and will then erase all of them.

Also, you may just want to turn off the RealSky images for a bit, without actually deleting them. The "RealSky shutoff" option lets you do just that.

The next operation, "Get A1.0 data", makes use of a new star catalog created by the USNO (US Naval Observatory). This enormous catalog contains almost 500 million objects. It consumes a set of ten CD-ROMs and is the current record-holder for most detailed dataset. Getting a set is not easy; the USNO didn't make many, and reserves them for especially deserving applicants. You can, though, download A1.0 data for a small region through

http://www.lowell.edu

(Note that this URL may change!) If you download an area in the "binary format" available at this site, and store it with the filename A10.DAT, then Guide will read the data, just as if you had extracted it from an A1.0 CD-ROM.

If you have the CDs, you can extract data from them and view it in Guide with the "Get A1.0 data" option. Click on it, and enter a desired field in arcminutes. As with RealSky, this can be rectangular ("30x20" for an area 30 arcminutes wide and 20' high); and you will be prompted to insert a particular CD-ROM. (In some cases, you may be asked for a second CD.) And again, Guide will recover control and will show the A1.0 stars.

The USNO also makes a single-CD "Selected A1.0", or SA1.0, version available freely; check

http://www.usno.navy.mil/pmm

for current availability information. The SA1.0 data can also be viewed in Guide, in the same manner as A1.0 data. When Guide asks for a particular A1.0 CD, you just insert the SA1.0 CD; Guide will automatically recognize it and will extract data from it.

The SA1.0 does have some drawbacks, though. It contains about 50 million of the A1.0's 500 million stars; they were selected to provide good astrometric (positional) data, meaning that they will not be the



brightest 10% of the stars. It is therefore not at all useful for making star charts (nor was it ever meant for such a use).

There is no separate menu option to clear the A1.0 or SA1.0 stars. Instead, you just enter a field size of zero.

When A1.0/SA1.0 stars are displayed, you can click on them to get information and "more info" about them, and you can generate lists of them using the "Create star list" option described on page 57. Because these catalogs were generated from blue and red photographic plates, they contain color data (unlike the GSC); if you turn Colored Stars to On (see page 23), the A1.0/SA1.0 stars will appear in color.

As of this writing, a new version, A2.0 (and SA2.0), are about to be released. Once CDs are available, support for them will be added to Guide, and updated software posted on the Web site. Guide will probably read A2.0 data downloaded from the Web sites, though this has not been tested yet. If it fails, you may need to get an update from the Web site.

The Edit Comet data option allows you to add new comets and asteroids by entering their orbital elements. This is described in some detail on page 81.

Use of the "Edit Comet data" option does require you to have some understanding of how orbital elements work, and to enter enough numbers to be tedious and error-prone. If you have access to the Internet, the "Add MPC comets/asteroids" option may be a good alternative.

The MPC (Minor Planet Center) has very kindly provided orbital elements for comets and asteroids, suitable for use in Guide, on its Web site. You can get data for currently visible comets, "Critical List" minor planets, and distant minor planets (those beyond the orbit of Saturn). The files can be downloaded from

http://cfa-www.harvard.edu/cfa/ps/Ephemerides/Soft02.html

in either ASCII text or HTML format (Guide can use both, so it doesn't matter which you use.) Once you have downloaded the data you'd like to use, click on the "Add MPC comets/asteroids" option. Guide will ask for the name of the file you've downloaded; provide it, and Guide will add new objects and update old objects using that data.

Alternatively, if you subscribe to the Minor Planet Electronic Circular (MPECs) distributed via e-mail by the MPC, you can specify a file containing one or more Circulars. Guide will comb through it for orbital data, and add the orbits to its database.

The Time Box has been quite carefully designed to simplify setting the time using the mouse. But there are still cases where one would prefer to set the time "directly", with the keyboard. The "Enter Time" option allows you to do that. (You can also reach it with the Ctrl-F9 hotkey.)

With this option, Guide accepts times in any of these formats:

'13/6/1987' to reset the date to 13 Jun 1987;
'13/6' to reset the date to 13 Jun of the current year;

'16:45:02' to set the time to 16:45:02 of the current day;
'16:45' to set the time to 16:45 of the current day;
'13/6 16:45:02' to reset the time to 16:45:02 on 13 Jun of the current year;

Any similar combination of the first two cases (resetting day) with the next two cases (resetting time of day);

'+27.3' to advance the current date by 27.3 days;
'-10.4h' to back up the current date/time by 10.4 hours;
'+2356m' to advance the current date/time by 2356 minutes;
'-63s' to back up the current date/time by 63 seconds;
'J2450540.321' to set the current date/time to JD 2450540.321

Most people outside the US use dots instead of '/'s to separate day, month, and year; so this option will also accept '13.6.1987' and similar text, in place of '13/6/1987' and similar text.

By default, Guide works on "fixed levels": for example, one goes from a field of view of 20 degrees (at level 4) to one of 10 degrees (at level 5), with no intermediate step. You can't access a "level 4.5, 15-degree" field of view; the best you can do is to change level 4 or 5 to be equal to 15 degrees, using the Set Level Size option in the Settings menu (p. 34).

The way to get around this clumsiness is to turn Fixed Levels off. When you do this, dragging a box open on the screen lets you choose a continuously varying field of view, instead of jumping from one level to another. You can still "go to level 4" to get a 20-degree field of view, and other aspects of zooming in and out are unaffected. The only real change is that you can get those intermediate fields of view.

The "Line of Variation" function is a very specialized option, added for use by people trying to recover comets and asteroids with poorly-determined orbits. In most such cases, the object won't be recovered exactly at the predicted position; instead, it will be found on a line passing through the predicted position, called the line of variation (LOV).

To show this, click on the Line of Variation option. Guide will ask for the length of the line in days; a starting value of one day is usually a good idea. (This corresponds to a guess that the object may be one day "ahead of prediction" or "behind prediction".) Guide will display a one-day LOV for all asteroids and comets on the screen, indicating the set of points where they would most probably be found.



To turn it off, return to this menu option and enter an LOV length of zero days.

The "Toggle user datasets" option is slightly misleading. In reality, Guide already contains a number of datasets in the user dataset system, including catalogs of galaxies, quasars, radio objects, nearby stars, the Palomar survey plates, and so forth. These are essentially intended as examples, but they also can be of use by themselves.

Hitting "toggle user datasets" brings up a list of these datasets, plus any you may have added using the instructions on page 66 or by downloading data from the Project Pluto Web site. You can click on those you wish to toggle to be on. When you hit OK, the list box vanishes, and Guide draws the datasets. You can then print charts showing the objects, or click on them, or get "more info" about them.

The "Make PostScript file" option is described in detail on page 50.

"Make .BMP File" provides another way to create graphics files for use in other Windows applications (most Windows paint programs will import .BMP data). To use it, set up your chart in the manner in which you want it to appear in the image, and click on this option. Guide will show the usual Windows "open file" dialog box, and will create a .BMP chart with the same dimensions and colors as the current Guide window.

The final two options, "Find Conjunction" and "Show Eclipse", are described in the following chapter.

## 18: ECLIPSES, OCCULTATIONS, TRANSITS

One of the most powerful features in Guide is the ability to make charts showing the paths on the earth cast during events where one celestial object blocks out (part or all) of a second object. This includes events such as solar eclipses, lunar occultations of stars and planets, occultations of stars by planets and asteroids, transits of Mercury and Venus in front of the Sun, and the (extremely rare) cases where one planet occults another.

In this chapter, all events of this sort will be called "eclipses", to evade the phrase "eclipses, occultations, and transits".

To show such charts, there are a few steps you have to do first. You need to set Guide's date and time to sometime close to the actual conjunction or eclipse. (For an example, there have been numerous solar eclipses. By setting the date and time, you tell Guide in which event you are interested.)

Next, right-click on the objects in question. For a solar eclipse, you would perhaps use "Go To... Planet" to find the sun, and right-click

on it, and click OK; then similarly find the moon, and right-click on it, and again click OK. (The "Go To" steps may be unneeded, if the objects are already visible on the screen.)

Similarly, for a case where an asteroid occults a star, you would right-click on the asteroid and click OK, then right-click on the star and click OK.

Once you have done this, the "Find Conjunction" and "Show Eclipse" options in the Extras menu will no longer be grayed out. Click on "Find Conjunction", and Guide will pause briefly while finding the nearest (or next) conjunction of those two objects. (From Guide's point of view, "conjunction" means "closest apparent approach of the objects to each other"). It will reset the time and show you the conjunction of those objects.

If one of the objects is the moon, Guide is bright enough to realize that conjunctions occur at roughly 27-day intervals; you can click on "Find Conjunction" repeatedly to show subsequent conjunctions.

Alternatively (or in addition), you can click on "Show Eclipse". Guide will clear the screen and switch from drawing charts of stars to drawing charts of the earth; you'll get a world map, and the path of the event in question will be shown. (Depending on your computer speed, this may take a few seconds; it is a very math-intensive task!)

The path will usually be in light gray, shading to blue in regions where the sun is above or near the horizon. Also, regions where an eclipse is partial will be shown in various shades. (Keeping in mind that, for occultations of stars, there is no such thing as a "partial eclipse".)

Of course, it's always possible that Guide won't find an eclipse, because one didn't happen that time. If the moon is one of the two objects you clicked on, Guide will again be bright enough to check for eclipses in subsequent months until it finds one. It can apply a similar search for transits of Mercury and Venus. In all other cases, you'll get an "Eclipse not found!" message if the event isn't visible from Earth.

Much of the techniques used in drawing sky charts have been recycled for the earth/eclipse charts. You can zoom in or out, print charts, set display levels, and so forth much as you did before. If you right-click on the chart, you can get contact times for the event as seen from that point. The menus are heavily rearranged to cut out options such as "star display" that make sense for charts of the stars, but which are meaningless for charts of the earth.

If the event is a lunar one or a transit of Mercury or Venus, you can use the "Next" and "Previous" options at the top to search for



the following or preceding event.

Two options in the "Extras" menu are deserving of mention. Suppose you want to know when the next eclipse visible in London is. You would zoom in on that city, putting it at the center of the chart; and toggle the "Local Events Only" option in the Extras menu. The "Next" and "Previous" options will then keep searching until they find an event visible from that point.

In the case of solar eclipses, there may be a lot of partial events found in this manner. So you could then toggle the "Partial Events" option in the Extras menu. Doing that would force Guide to insist not only on events visible from London, but that they be total or annular as well. This makes determining the next total eclipse visible from a given point quite easy to do.

Finally, when done, you can go back into the Extras menu and click on "Show Eclipse" again, and Guide will return to charting stars.

## 19: SAVING AND GOING TO MARKS

At any time, you can save your present view as a mark file, and recall it at any future time. You do this via the "Save a Mark" and "Go to Mark" options in the File menu.

When you ran INSTALL or SETUP, it copied a few sample mark files to your hard drive. Click on "Go to Mark" and take a look at them.

The sample marks point to "interesting" astronomical events and times. "Gervase occ. in 1170" shows Mars crossing in front of Jupiter. This sort of planet-crossing-a-planet event occurs about once a century; the next time one will occur is in 2065. The most recent was in 1818. The one shown here was recorded by a monk known as Gervase of Canterbury in 1170, and also by the Chinese Imperial Observatory.

Another mark file, "Earth transit from Mars", shows the Earth silhouetted against the Sun as seen from Mars. This sort of event is called a transit; from time to time, we on Earth see Venus and Mercury cross the Sun's disk. Such events do not occur frequently; for example, transits of Venus as seen from Earth occurred in 1874 and 1882, and the next transits will occur in 2004, 2012, and 2117. The particular event shown here was calculated by Jean Meeus (see the acknowledgments) and used in a short story, "Transit of Earth", by Arthur C. Clarke. Had you been on Mars with a filtered telescope, you would have seen a small black disk crossing the sun, with a disk a quarter that size (the Moon) trailing behind. It does illustrate how big the Sun really is.

The "Jul '91 Mexico eclip" shows the total solar eclipse of July 11, 1991, as seen from Mexico City. The "May '94 annular ecl" shows the less dramatic annular (doughnut-shaped) solar eclipse that was visible from Project Pluto's corporate headquarters. In this case, the moon

wasn't large enough to block out the sun, and a ring of sun was visible around the moon.

The "Initial position" mark file is used when the program starts up, and ensures that you resume where you were when you last ran Guide, with whatever settings you had at the time. If you happen to get your settings thoroughly confused, you can select this mark file to restore things to the way they were when you started the program. If this does not restore things properly, you can use the "Factory default settings" mark, which puts everything back the way it was when Guide was installed.

You can save a mark by hitting "Save a Mark". You will be asked to type a mark name, which must be less than 20 letters. You can also delete an existing mark file with the "Delete Mark" option. This option will bring up a list of mark files; select one, and you'll be asked to confirm that you wish to delete that mark file.

## 20: USER-ADDED (.TDF) DATASETS

As delivered, Guide displays an extremely wide variety of datasets covering all kinds of celestial objects. However, some people will have the need or desire to add objects from completely separate datasets previously unknown to Guide. The user-added dataset capability lets you do this.

The basic idea is a pretty simple one. Most databases are in plain ASCII text or FITS files, with data arranged in columns. Guide will absolutely need to know certain basic things about the database, such as which columns contain the RA hours data, which the declination minutes, the file name of the database, the epoch of the coordinates, and so on.

All of this information is stored in a Text Definition File (.TDF). There are two examples provided in your Guide directory, CD_DATA.TDF and RADIO.TDF. Each contains definition data for several datasets on the Guide CD. Even if you have no real desire to add your own datasets, the pre-defined datasets in these .TDF files can be useful, giving information on radio objects, quasars, nearby stars, binary stars, and more.

The display of these pre-defined datasets is controlled with the "Toggle User Datasets" option in the Extras menu. When you first use this, only the pre-defined datasets will be shown in the list box, and you can turn them on or off. Once displayed, they can be clicked on and "more info" data generated. You can find objects in them using the "Go to .TDF Object" option described on page 10.

Of course, the really nice thing about this is that it allows you to add completely new and different datasets to Guide. The process for doing this is described below. Be aware that this is not a completely trivial process! If you don't know something about the format of the



dataset you plan to add, or are not familiar with a text editor, you should not attempt to do this.

Unfortunately, the .TDF format is quite Guide-specific, because there are no real "standards" in this area. FITS files were a possible standard, but are (despite the name) far from standardized, are hard to edit using standard text editing tools, and lack many useful features.

There are currently two .TDF files: RADIO.TDF (defines the format for the radio catalogs) and CD_DATA.TDF (for all the other datasets listed above). One can freely add new .TDF files; Guide will automatically detect them and display the data defined by them. You can move datasets freely from one .TDF file to another, or combine them all; the default two .TDFs just made dataset management a little simpler.

If you edit either .TDF file with a text editor, the format used will probably be quite clear. There are a lot of fine points to be considered, though, as you will see on the following pages.

As you can see, each dataset in a .TDF file starts with two lines such as:

```
file !:\radio\quasars\table1.dat
title Quasars
```

(The '!' stands for the CD-ROM drive letter; it probably will be of little use to you, since your datasets will come from someplace else.) These lines, of course, simply tell Guide where to find the data and what to call the dataset when it's listed in dialog boxes. Each dataset ends with the

```
shown 0
end
```

commands (or "shown 1/end", if the dataset is turned on). The lines in between, however, will vary widely between datasets.

All datasets will have a description of the format of coordinates. For example,

```
RA H  20   2
RA M  23   2
RA S  26   4
de d  30   3
de m  34   2
de s  37   2
```

tells Guide that, in this dataset, the RA hours of an object is stored in columns 20-21 of each line; the RA minutes in columns 23-24; and the RA seconds in columns 26-29. Quite a few datasets will omit the RA S, de s, and/or de m fields, because they use decimal degrees

or minutes; this is not a problem for Guide.

The following lines may also appear in a dataset description:

```
mag    40    5     # Magnitude is in columns 40 to 44
sizs   33    5     # Size,  in decimal seconds,  in columns 33 to 37
resize .5          # Multiply "size" by .5 to convert diameter to radius
text    2   17     # Text for labelling this object,  in columns 2-18
epoch 1950         # This dataset provides B1950.0 coordinates
offset 23040       # The actual data starts 23,040 bytes into the file
line size 102      # Each line in this dataset is 102 characters
nlines 7437        # There are 7437 lines in this dataset
sort 1             # The dataset is sorted in increasing RA
type    4          # The dataset is shown with symbol 4 = galaxy
type sc15;e0,0,32;c1;E20,20,12;E-20,-20,12;c2;m-45,0;l45,0;c14;
type sc4;f3;-10,-5;10,-5;0,10;c2;
# Above two lines are user-created symbols
align 32           # The text labels are aligned at the bottom left
```

The first line tells Guide that magnitudes are stored in columns 40-44 of each record. This will be used in, for example, determining the size at which stars are drawn.

Along with the "sizs" (size in decimal seconds), one can use a "sizm" (size in minutes) or "sizd" (size in degrees). "resize" is useful for converting a diameter to a radius (as shown above), or from converting from arbitrary size units.

The "text" line tells Guide what data to use in labelling objects (if any; some datasets don't have any designation to add to the object.)

If the dataset doesn't start right at the beginning of the file, you will have to add the "offset" keyword to tell Guide how many bytes to skip. This will always be needed with FITS files.

In general, if you are dealing with simple text files, you can ignore the "line size", "nlines", and "sort" keywords. But if every record is exactly the same length (as happens in many text files and in all FITS files), it can help to provide these fields. If the dataset has no carriage return or line feed at the end of each line, they are absolutely essential.

If you've provided "line size" and "nlines", _and_ the data is sorted in order of increasing RA, then it's a _good_ _idea_ to add the "sort 1" keyword. If Guide knows the dataset is already sorted, it can skip over large amounts of data and draw your dataset _much_ faster! Fortunately, many datasets are provided in this order, or are small enough to make this improvement less important.

Also, you'll need to provide a "type" keyword, to tell Guide how to display the object. The pre-defined values for "type" are...



```
0 = open clus
1 = globular
2 = diffuse neb
3 = planetary nebula
4 = galaxy
5 = OC & neb
6 = star
7 = triangle
8 = radiation symbol (for X-ray or gamma-ray sources)
9 = radio dish (already used for all catalogs in RADIO.TDF)
```

For all types except 6 (star), the symbol size will be scaled by the "sizs" (or "sizm" or "sizd") data. Stars are sized by the "mag" data.

## 20a: Defining your own custom .TDF symbols

Using a pre-defined type is easy. But you can also create your own symbols. To do this, you need to alter the 'type' line in a .TDF. An example is:

```
type sc15;e0,0,32;c1;E-20,-20,12;f3;-10,-5;10,-5;0,10;c2;m-45,0;l45,0;c14
```

The 's' stands for 'symbol', and tells Guide you aren't using the usual pre-defined symbol types. Following are commands separated by semicolons:

```
c15;                     means set color 15 (white)
e0,0,32;                 means draw a 32-unit circle centered at (0,0);
c1;                      means set color 1 (green)
E-20,-20,12;             means draw a 12-unit _filled_ circle at (-20,-20);
f3;10,15;30,15;20,30;    means draw a 3-point _filled_ object (a triangle)
                         connecting (10,15) to (30,15) to (20,30)
c2;                      means set color 2 (brown)
m-45,0                   means move to (-45,0);
l45,0                    means draw a line connecting to (45,0);
c14;                     means set color 14 (light gray)
```

The symbols are scaled just like the standard, predefined types; large objects are drawn with scaled-up symbols, just as large (for example) globular clusters are drawn with larger circles. The unit of measurement in the above commands is 1/32 of an object radius. For example, the 32-unit circle drawn above would exactly match the size of the object.

By setting the color to light gray at the end, we make sure that the label for this object is in light gray.

Here's a more practical example. Suppose you want to show a catalog of gamma ray burst events with radiation symbols: three triangles in light blue, with orange dots in the center.

```
type sc3;f6;-32,0;32,0;16,26;-16,-26;16,-26;-16,26;c2;E0,0,15;c14;
```

The three triangles are drawn as one six-point fill (that's the 'f6;' part). Then the color is set to 2 (orange) and a dot is drawn. Finally, the color is reset to 14 (light gray) for the label.

The 'align' keyword is the sum of a number for the horizontal alignment (0 for left, 1 for center, 2 for right) and a number for the vertical alignment (0 for top, 16 for center, 32 for bottom). By default, the alignment is zero, and text is shown to the upper left of an object.

**20b: Providing limits in RA and declination**

By default, Guide will assume that your dataset covers the entire sky, and will always examine it to see if any objects fall on the screen. Often, this is a waste of time. In such cases, you can tell Guide what rectangle of sky your dataset covers.

For example, if you look at RADIO.TDF, you'll see that the 6C Radio Sources II dataset has the following fields in it:

```
declimit 30  51    # This catalog extends from N 30 to N 51
ralimit 8.5 17.5   # This catalog extends from 8h30m to 17h30m in RA
```

It just so happens that this particular dataset covers a particular "rectangle" in RA/dec. Since Guide knows this, it can (often) compare that rectangle to the one on the screen, find that there is no overlap, and deduce that there is no point in even considering this dataset any further. If you have a lot of datasets each covering a small area (such as the sections of the 6C radio survey), this can speed matters up substantially.

The "ralimit" field is unusual, but the "declimit" one is not. For example, most datasets created in the Northern Hemisphere have a southern declination limit (except for neutrino-based observations).

**20c: Adding "More Info" and "click" data for your dataset**

You will notice that each dataset also has a few lines starting with a tilde (~), followed by "c", "r", or "b". Each of these lines involves showing some data when the object is clicked on, when you get remarks ("more info"), or both, respectively.

After the "~(letter)",two numbers are given: the starting column and length (as was true for most of the fields already discussed). Guide first checks to make sure that this field is not blank. If it is indeed not blank, Guide shows that field, using the remainder of the "~" line to decide what the format should be.

For example, the following line (from the quasar dataset):



~r 46 5 ^Color index^ (B-V): %s\n

tells Guide that the quasar dataset stores color index data in columns 46-50. If Guide finds data in those columns (this is not a "given", since not all quasars have had their color indices measured), then Guide will show "Color index (B-V):", the color index, and then skip to a new line (that's what the '\n' means). Because this is a "~ r"line, Guide will only show this data in the Remarks, i.e., when you click for more info.

Because "Color index" is in carets (^), Guide will show that text highlighted; when you click on it, you'll get a glossary definition.

Some datasets store data as special flags. For example, in the quasar data, column 22 can contain an "A", "O", "R", or just a blank space. Each flag has a meaning. The following lines in the .TDF file translate:

```
-r 22 0 A Position is of low accuracy\n
-r 22 0 O Position was found optically, and is good to 1" or better\n
-r 22 0 R Position was found by radio, and is good to 1" or better\n
```

As it stands, nothing is shown if column 22 is blank, but using

```
~r 22 0   Position is not of low accuracy\n
```

(or something similar) would fix that problem.

**20d: Adding note files for .TDF datasets**

It is also possible to add note files for a .TDF dataset. There is only one example available, for the Binary Star data (BINORBIT.DAT), the last dataset defined in CD_DATA.TDF.

You'll notice that the format description for BINORBIT contains this line:

```
~n  2  15 binorbit.not
```

In plain language, this means "Notes for this dataset are found in the file BINORBIT.NOT, and are indexed using the fifteen characters found starting at byte #2 in lines from BINORBIT.DAT."

This example was chosen because the binary orbit dataset already provided notes for most of the stars, indexed by their RA/dec values (which are given in BINORBIT.DAT in columns 2-16). You will see that the .NOT file itself is of the sort common in Guide: the object is specified with a tilde (~) plus the object identifier, and then text is given for that object.

## 21: Adding your own notes for objects

Not many people will have a need to add their own datasets, except for some special-purpose projects. A more common wish is to add some comments for an object. If you know how to use a text editor, this is quite simple to do.

For example, let's say that you have just observed NGC 253, and would like to make some notes on what you saw. Go to your text editor, and edit the file NGC.NOT in your Guide directory.

You'll see that a few notes have been added already, mostly telling you what supernovae have appeared in which galaxy. This is admittedly not very crucial data; it's supplied mostly to give an idea as to how the system works. You'll also see that some notes have already been supplied for NGC 253. Try extending that text to read something like:

~253
The ^supernova^ 1940E was found in this galaxy on 1940 Nov 22 at RA 00 45.1, declination -25 34 (epoch B1950), magnitude 14.0.
On 23 Aug 1997, I observed this galaxy with a 10" f/4 Newtonian and saw that...

Of course, you can add remarks for new objects by inserting "tilde-number"s for them. There are similar files for a variety of other objects: IC.NOT, UGC.NOT, ASTEROID.NOT, and PLANETS.NOT. The system has to be modified in cases such as COMET.NOT and PK.NOT; you'll see that these files use a tilde-plus-name system, since tilde-plus-number would not be very helpful.

The system can even be extended to cover datasets you have added to Guide with the user-added dataset system; see page 71 for details.

## 22: USE IN THE FIELD

Many users use Guide next to their telescopes, on a laptop or an old desktop. Steps have been taken in Guide's design to make that more comfortable.

First, it is possible to use the DOS version of Guide with only a mouse. The alphabet and digits appearing in the dialogue box whenever you are asked to enter something via the keyboard can be clicked on with the mouse to simulate keyboard entry. This is clumsy. On the other hand, trying to type in total darkness is nearly impossible.

Secondly, the "Normal Colors" entry in the Display menu, stating that Guide is using its normal palette of colors, can be clicked on, resulting in that entry changing to "Red Stars". This option turns the chart to red (in the DOS version, it changes _everything_, including



menus, to red). Studies have shown that red light will leave your night vision relatively intact. If you run Guide in the field without using this option, your eyes will never fully adapt to darkness, and you won't see as much in the sky as you ought to.

In Windows Guide, this can only affect the charts drawn by Guide. The colors of the menu and title bars are controlled by Windows; you can reset them in the Control Panel (Win3.1) or Color Manager in the system group (Win95). On the positive side, once you have persuaded Windows to draw things in red, all software will be changed, including programs whose authors did not include this option.

## 23: ABOUT GUIDE'S DATA

As has been mentioned, Guide draws its data from a number of sources. It can be helpful to know something about these sources: their limits, purposes, and uses. This chapter will discuss these issues.

For stars brighter than about mag 11, Guide uses the Hipparcos and Tycho Catalogs. These catalogs were both generated by the European Space Agency (ESA) Hipparcos satellite, and are often spoken of as if they were essentially identical. They are not, and in some cases, the differences can be very significant!

The Hipparcos catalog contains 118 218 stars that were primary targets for observation. Most are bright stars, but a few dimmer stars that were of special interest were included: mostly nearby stars and some variables. The satellite gathered positions to a precision of about .001 arcsecond, and highly precise proper motions, parallax (distance) data, and magnitudes in visual and "blue" systems, for these stars. (Some were more precise, some less so; the specific data for each star is listed when you ask for "More Info" about it.)

The Tycho catalog contains a total of 1 052 031 stars. It attempts to be complete down to the limit of what the instrument in the satellite could observe (about magnitude 12), and measured the same things as Hipparcos. But its precision is considerably less than that of Hipparcos. The magnitudes and positions are still better than those from any other catalog. The original proper motions were slightly worse than those in some older catalogs such as the PPM, because the Hipparcos satellite was not aloft for long enough to get a long baseline of observations. But those proper motions have mostly been replaced with data from the new USNO ACT (Astrographic Catalog/Tycho), which has resulted in proper motion data of quite good quality.

The Hubble Guide Star Catalog (GSC), version 1.1, is used for dimmer stars, down to about magnitude 14 or 15. It was compiled for use in fine-tuning the aim of the Hubble Space Telescope. It is the most detailed star catalog widely available, with about 15 million stars. However, it does have some oddities.

It was generated by scanning in survey plates from two telescopes, the Palomar Schmidt camera in California and the U.K. telescope in Australia. As with the SAO, the main intent was to get enough stars to be confident of having some guide stars in a given field of view. In dense areas such as Sagittarius, they could get away with a magnitude 13 limit and would have the required density. In vacant areas like Virgo, it was necessary to go to mag 15 or 16. That's why the limiting magnitude of the GSC (and of Guide) varies as you move in the sky.

Objects were automatically collected and classified as stars or non-stars, with varying degrees of accuracy (thus the switch to turn off "Non-Stars" in the Star Display menu). A more complete description of how the GSC was made can be found in the information distributed with the GSC and copied onto the Guide CD, in the TABLES directory.

For purposes of aiming, you need accurate positions, and the GSC positions are indeed usually accurate to a better than one arcsecond. However, you don't really need accurate magnitudes for aiming. Each plate was calibrated using stars near the center of the plate; the fact that stars at the edge get distorted wasn't taken into account, and stars at the edges of plates get inaccurate magnitudes (usually about .5 magnitude errors). Also, some plates provide magnitudes corresponding to what a human eye would see ("visual" magnitudes), while others were sensitive mostly to red light, making red stars seem brighter than they would look to a human.

For finder charts, this is not necessarily a problem. All the stars in a given region will be offset in brightness by roughly the same amount, and you will be able to use the chart to find your way around the sky. However, if you want to estimate the magnitude of an object by comparing it to a GSC star, the errors may become evident.

Another problem with the GSC has to do with completeness. While it has millions of magnitude 14 and 15 stars, it omits a few of the brighter stars. Again, for purposes of aiming the Hubble Space Telescope, this did not upset the creators of the GSC very much. But it can be a little disconcerting for the rest of us.

While the Hipparcos/Tycho Catalogs and GSC are used for display of stars, when you click for "More Info" on a star, you may get data from many other catalogs. Guide will attempt to cross-reference to the SAO (Smithsonian Astrophysical Observatory), HD (Henry Draper), Yale, GCVS (General Catalog of Variable Stars), WDS (Washington Double Star), PPM (Position and Proper Motion), and NSV (New Suspected Variable) catalogs. Each will either provide additional data, or a cross-check on the data you've seen in other catalogs, or both.

There are five galaxy catalogs on the Guide CD-ROM. The PGC (Principal Galaxy Catalog 1996) of over 100,000 galaxies forms the



basis for display of small fields. Data is also shown from the RC3 (Third Revised Catalog), the Uppsala General Catalog (UGC), the Morphological Catalog of Galaxies (MCG), and the European Southern Observatory extension to the UGC (ESO/Uppsala).

As with any other problem you may find with Guide, please let us know if you find any problems in the data. At the very least, error reports can be passed on to those maintaining the data.

## 24: ACCESSING GUIDE'S DATA

Quite a few programmers have asked about accessing the data on the Guide CD-ROM from their own programs. In certain cases, this can be easy to do; some of the data (for example, all of the "user datasets") are in their original ASCII form, and are well-documented. In others, it can be a difficult undertaking (e.g., the GSC, Tycho, and PPM data). The compression really is not intended to frustrate people. But a quick check will show you that the CD-ROM is almost completely full; unless many larger datasets were highly compressed, something would have been omitted.

Because of the concern about fitting everything on the CD, a lot of effort went into compressing the larger datasets. Little was usually done to smaller datasets, since compressing them would not have helped very much anyway.

Full details on accessing the datasets are available in the file \WEBSITE\ACCESS.HTM on the Guide CD. This gives a list of what datasets exist on the CD, what formats they are in, and what code exists for decompressing them.

## 25: ACKNOWLEDGMENTS

Much of the data for this CD came from the National Space Science Data Center. In particular, the data on galaxies, the SAO and HR catalogs, and much of the data on asteroids except for magnitude and position information came from their CD-ROM of "114 Selected Astronomical Catalogs." This is a truly amazing wealth of astronomical information.

The Hipparcos and Tycho data were created by the European Space Agency, and are used here by permission.

The National Space Science Data Center (NSSDC) (telephone (301) 286 6695; Goddard Space Flight Center, Greenbelt, MD 20771) has a free catalog describing a wide variety of astronomical data. Since all of it is federally funded, it is available at very low cost: the first CD-ROM in a given series is $20, and subsequent CDs are $6. They sell data from the Einstein X-ray Observatory, IRAS Sky Survey, Magellan (33 CD-ROMs at full resolution!), the aforementioned 114 Selected Astronomical Catalogs CD, Viking Orbiter images and data, a 12 CD

series of Voyager images of the four gas giants and their moons (over 26,000 images), and much more. Some of the Voyager images are on this CD-ROM.

In this connection, thanks are due to Steve Green, who gave permission to put his copyrighted freeware software, PDSWIN, on the Guide 6.0 CD (check the PDSWIN directory). This software is an excellent tool for viewing the Voyager images (stored in the VOYAGER directory of the CD).

The most detailed data came from the Hubble Guide Star Catalog, version 1.1, distributed by the Space Telescope Science Institute. This dataset was originally intended to support precise pointing of the Hubble Space Telescope, and is the major data source for Levels 7 through 20. It can be purchased, in its original form on two CD-ROMs, through the Astronomical Society of the Pacific, 390 Ashton Avenue, Dept. 941AD, San Francisco, CA 94112; phone (415) 337 2624.

The Guide Star Catalog (GSC), version 1.1, is copyrighted by the Association of Universities for Research in Astronomy (AURA), and is reproduced here by permission. The scientific efforts leading to the production of the Guide Star Catalog are described in Volume 99, pp 2019-2154 of the Astronomical Journal, and in text files on the CD-ROM version of the GSC from which data contained herein were extracted. Those text files are also on this CD in the TABLES subdirectory.

The PGC (Principal Galaxy Catalog) was obtained from the Universite de Lyon. It was compiled by G. Paturel and L. Bottinelli of the Observatoire de Paris, and forms the basis for displaying galaxies at detailed levels.

The RC3 (Third Revised Catalog of Galaxies) was obtained from Dr. Harold Corwin, at the California Institute of Technology. It was compiled by G. and A. de Vaucouleurs, H. G. Corwin, R. J. Buta, G. Paturel, and P. Fouque. With the PGC, it is largely responsible for the great improvements in the accuracy and quantity of data provided for galaxies.

The GCVS (General Catalog of Variable Stars) was obtained from the NSSDC "114 Selected Astronomical Catalogs" CD, but is complete only to about 1982. Several thousand variables have been found since then; I obtained a list from Bob Leitner of the AAVSO, and use the list here by permission.

The NGC and IC data come from the Saguaro Astronomy Club. The members of this club did an enormous amount of work in cleaning up many errors in the RNGC and NGC2000 catalogs in the course of producing this work, and I am very happy to be able to make use of the results.

Nebula catalogs have long been a major problem for Guide; the Nebula Databank and isophotes created by Eric-Sven Vesting have almost completely reversed this bad situation, allowing Guide to provide



accurate information (and shapes) for all major nebulae and most minor ones. This tends to be very time-consuming labor, and a lot of hours were expended to check and cross-reference catalogs, and in extracting nebula isophotes from RealSky data.

The Nebula Databank and isophote data are copyrighted by Eric-Sven Vesting, and are used in Guide 6.0 by permission.

The asteroid data came from the Lowell Observatory ASTORB database, computed by Dr Edward Bowell. This represents a significant improvement over most past sources of asteroid data; in particular, the fact that it provides an indication of the precision of the orbit is most helpful. The research and computing needed to generate these data was funded principally by NASA grant NAGW-1470, and in part by the Lowell Observatory endowment.

Most of the mathematically intensive operations such as calculation of planetary and satellite positions and magnitudes, precession, and many related problems were solved using the methods in Jean Meeus' "Astronomical Algorithms" (Willman-Bell, 1991). If you are interested in the mathematical methods of astronomy, this book is a must.

Special thanks go to the translators for the various foreign-language versions of Guide: Eric-Sven Vesting (German), Jean-Noel Moreau (French), Alberto Romero (Spanish), Giuliano Pinto (Italian), Guus Gilein and Siebren Klein (Dutch), Masaki Kouda (Japanese), and Alexander Anikeev (Russian). These versions have been immensely helpful in making Guide easier for most of the world to use.

Most of the improvements incorporated since versions 1.0 through the present version were suggested by users on the response forms. Thanks go to all who took the time to indicate what was useful, what would be useful, and what was really a bad idea.

## APPENDIX A: RIGHT ASCENSION AND DECLINATION

Right ascension (RA) and declination are the celestial versions of longitude and latitude on the Earth. The celestial versions of the poles are found by taking the Earth's axis of rotation (which, of course, passes through the North and South poles) and extending it into infinity. The celestial equator is found by extending the Earth's equator into infinity, projecting it onto the sky.

On Earth, latitude is a measure, in degrees, of how far one is from the equator. Thus, the north pole is at +90 degrees; the south pole is at -90 degrees. This translates readily to the concept of declination in the sky: Polaris, the North Star, is at (close to) declination +90. You can express a declination as you would any angle: in decimal degrees, in degrees plus decimal minutes of arc, or in degrees, minutes, and decimal arcseconds. (The format Guide uses in displaying declination, and RA, can be specified; see page 36.)

RA is similarly analogous to longitude. The celestial version of the Prime Meridian is the Sun's location at the vernal equinox (the place where it crosses the celestial equator near 22 Mar). RA is measured from this point, all the way around the sky until the vernal equinox is reached again. There are two key differences between RA and longitude. In the first place, longitude is (usually) measured from -180 to +180 degrees. RA is never negative; it's similar to measuring from zero to 360 degrees (which is how some people do measure longitude.)

The second difference is that instead of being measured in degrees, RA is measured in units of time. The entire "distance" around the sky is not 360 degrees, but one day. A fraction of this distance can be measured in hours, minutes, and seconds. As with declination, this can be either decimal hours, hours and decimal minutes, or hours plus minutes plus decimal seconds. Guide will always accept input in any of these forms, and will figure out which method you used and thereafter show all positions in that format.

There is one twist on this situation. If you find the latitude and longitude of a point on the Earth, those values won't change significantly over time. The North Pole stays under the Arctic icecap, and Greenwich, England doesn't move. The situation is not so tidy for RA and declination, as described in the following appendix.

## APPENDIX B: PRECESSION AND EPOCHS EXPLAINED

If all you wish to do is to look at stars, or possibly find out what that bright planet you see each night at dusk is, you can probably skip this Appendix. If you need fairly precise positions, or wish to match a chart printed in Guide with one from another source, you probably should know the following:

The positions of stars and planets are usually described in terms of right ascension (RA) and declination (see the preceding appendix). One difficulty with using this system is that RAs and declinations are in constant change over time. The position of an object expressed in 1950 coordinates may be .7 degrees different from its 2000 coordinates.

The reason for this is that declination and RA are measured from the Earth, and the Earth doesn't stand still. The axis it rotates on slowly describes a circle in the sky, completed once every 25,800 years. This is why Polaris won't always be and hasn't always been the "North Star". This slow motion of the Pole is called precession. It's similar to what happens with a top; you've probably noticed that while the top spins rapidly, it also has a slower, "wobbling" motion. This motion makes a RA and declination alone are slightly ambiguous; you also need to know the year for which that position is valid. That year is called the epoch.

Most catalogs are in a "standard" epoch. Standard epochs are



separated by 50 years; some catalogs are still in the B1950.0 epoch, while most have been switched to J2000.0. If you read about the position of an object in a book or magazine, make sure you also get its epoch. This is especially important for dim objects. If you mistakenly looked for an object as dim as Pluto, say, in a J2000.0 position when it was really given as B1950.0, you would have no hope of finding it. (The difference is usually around half a degree.)

By default, Guide shows you positions and accepts positions in J2000.0. If you wish to change this, click on the epoch shown in the legend. (In the Windows software, you can instead hit Alt-E; in the DOS software, Ctrl-E.)

You can set the epoch in which grids, ticks, hatches, and/or side labels are shown separately; there is a menu item in the Spacings menu that lets you do this.

A brief note: You may wonder what the "B" before "1950.0" and the "J" before "2000.0" mean. The answer is: in terms of finding something, not much. In 1950, epochs were measured from the start of the Besselian year, which is 365.2421988 days long. In 1984, the International Astronomical Union decided to switch to the start of Julian years, which are exactly 365.25 days long. The actual difference in the sky is always well under .1 second of arc, and you can usually ignore these prefixes with very little harm. With the exception of Hipparcos and Tycho stars, no object in Guide can claim positional precision of .1 second or better.

## APPENDIX C: ALTITUDE AND AZIMUTH EXPLAINED

You will note that all objects, when clicked on, show times of rising and setting, plus their "alt" and "azim". This refers to the object's "altitude" and "azimuth", which tell you where in the sky to look for an object.

Altitude and azimuth are not reckoned from either the Earth's poles or the celestial poles. They are reckoned from the observer's position: the point straight overhead has an altitude of +90 degrees; that straight underneath, an altitude of -90 degrees. Points on the horizon have 0 degree altitudes. An object halfway up in the sky has an altitude of 45 degrees.

Thus, looking at altitude tells you immediately if the object is even visible. A negative altitude means the object is below the horizon. A positive altitude less than, say, +10 degrees, may make the object so close to the horizon that trees or buildings or smog may make it invisible.

Altitude gives you the "how far from the horizon"; you use azimuth to determine "which direction around the sky." An azimuth of zero degrees puts the object in the North. An azimuth of 90 degrees puts the

object in the East. An azimuth of 180 degrees puts the object in the South, and one of 270 degrees puts the object in the west. Thus, if Guide tells you that an object is at altitude 30 degrees, azimuth 80 degrees, look a little North of due East, about a third of the way from the horizon to the zenith.

The fact that altitude and azimuth are referred to things you can actually see (the horizon and the zenith) makes them very useful. Remember that Guide needs a correct time and lat/lon to provide correct alt/az values! The star you see straight overhead might not even be visible thousands of kilometers away; if you don't have the right lat/lon, Guide may well believe it is being run in Bowdoinham, Maine, and has never left Project Pluto.

It is quite simple to find a position by alt/az coordinates; the process is described on page 16.

## APPENDIX D: TROUBLESHOOTING POSITIONS

At some point in the use of Guide, you will not find an object at its expected position. This should not be too surprising. Guide has a huge array of settings, and if one or more is set incorrectly, positions will not be as expected. Check the following items:

EPOCH. The current epoch is shown in the RA/dec Format dialog and, usually, in the legend. By default, it is set to J2000.0, the current system of choice. Most galaxy catalogs, and a few other sources, are still in B1950.0 coordinates. The difference can be of the order of half a degree.

HOME PLANET. (see page 38). If you are observing the Solar System from, say, Venus, objects will obviously not be in the same place as if they were observed from Canberra, Australia. (Non-solar system objects are not affected. The parallax effect is ignored for them.)

LATITUDE/LONGITUDE. An object viewed from Texas will not be found in the same position as seen from Brazil. The difference is usually small, but some objects come close enough to the Earth for it to matter. Your altitude above sea level, set in the Settings menu, has a similar, but much smaller, effect.

The Moon can be shifted by up to 2 degrees if the wrong lat/lon is used. Asteroids and comets passing very near to the Earth can be still more seriously affected. Planets are usually not affected by more than a few arcseconds.

TIME. If the time is 13 days off from its expected value, make sure you are using the Gregorian calendar. Check the Time Zone setting. Remember that Guide uses a 24-hour clock; 8:13 PM becomes 20:13.



Finally, it's worth considering the precision of the source used for the "expected" value. Perhaps the most common source of error is the assumption that some software has generated a "precise" value, and that any difference must be due to errors in Guide. It may be flatly stated that, properly used, Guide will indeed generate data to the precisions listed in the next section.

## APPENDIX E: NOTES ON ACCURACY

The subject of the accuracy of any astronomy software is a very complex one. The accuracy of positions shown by Guide varies from about a thousandth of an arcsecond (for stars in the Hipparcos catalog) to being as poor as several degrees (for some asteroids whose orbits have not been thoroughly studied). For moving objects, the accuracy is also a function of time; that of positions of planets within a century of the year 2000 is of the order of milliarcseconds, but probably no better than arcminutes for very distant dates.

There is a very thorough description of accuracy in the files:
\TEXT\ACCURACY.HTM (HTML version)
\TEXT\ACCURACY.TXT (text version).

These describe what level of accuracy can be expected for various data in Guide, how that level was determined, and what factors can affect that level of accuracy. If your sole need is to be able to find objects visually or telescopically, then the accuracy given by Guide will always be far more than sufficient.

## APPENDIX F: ADDING NEW COMETS

Guide is shipped with a fairly complete list of comets and with a set of over 20,000 asteroids. (The database actually lists over 32,700 asteroids, but the last 12,000 or so have very uncertain orbits and are probably lost.) New comets and asteroids are always being discovered, and in some cases, new observations allow the precision of existing orbits to be improved. Guide will be fairly up to date on comets when you receive it; as new ones are discovered, they are added toCOMETS.DAT. Guide will also show some future comets such as Halley in 2061 and P/Swift-Tuttle's next return in 2126, because these comets were observed carefully when last visible and their future orbits computed. However, new comets will be discovered after you receive Guide (usually, a few are found each year), and you may want to display them in Guide.

If you have access to the Internet, the easiest way to get up-to-date orbital elements is to download them from the Minor Planet Center WWW site, then use the ""Add MPC comets/asteroids" described on page 61 to bring them into Guide's database. This method guarantees good, current data, and removes the need to understand orbital elements. If you lack such access, or if you want to add elements not available through the MPC, then you should use the

methods described below.

If you receive magazines such as Sky & Telescope, Astronomy, or similar publications, you will sometimes see articles about new comets and asteroids listed with orbital elements given. Such data is also given on many electronic bulletin boards, and is distributed in announcements from the Minor Planet Center. These elements can be used by Guide.

First, some background on how an orbit is defined: Usually, five or six figures, called orbital elements, are needed. When you "click for more info" on a comet or asteroid in Guide, these elements are among the information listed.

Orbital elements can be expressed in a variety of ways. Usually, a comet's elements consist of a time of perihelion (the time it comes closest to the Sun), represented by a capital letter T; the distance from the comet to the Sun at the time of perihelion, or "q"; the orbit's eccentricity (a measure of how "stretched out" the orbit is; a value of 1 or greater means the comet won't return), or "e"; the longitude of the ascending node, represented by an uppercase Omega (looks like a horseshoe); the inclination, or "i"; and the argument of perihelion, represented by a lowercase Omega (looks like a curly w). These last three are angles that define how the orbit is oriented in space.

Asteroid elements usually replace the time of perihelion with an epoch time and a "mean anomaly", an angle defining the object's position along the orbit at the epoch time. Also, the semimajor axis ("a") is sometimes used in place of the perihelion distance.

To add a new asteroid or comet to Guide, use the "Edit Comet Data" option in the Extras menu. First, Guide will provide a list of recent comets, plus "(new comet)" and "(new asteroid)" entries. You can select an existing object to alter it (useful for element updates), or either class of new object.

Next, you'll get a menu allowing you to adjust and save all the elements labeled above. Because orbital data tends to confuse the uninitiated (and, at times, the initiated), there is a paragraph or two provided on the screen to clue you in to what the variable in question means.

After entering all the elements, you can save the results, and Guide will add that comet or asteroid to its list. Keep in mind that the new object obeys the same rules as any comet: if you have comets turned off in the Data Shown dialog, or if the comet is not brighter than the limiting magnitude for comets, it will not show up on the chart.

Two items need special mention: the "magnitude parameters". These



are almost always listed with asteroid elements; sadly, people are often sloppy about providing the magnitude parameters for comets. One method to find the absolute magnitude parameter is to enter a "guess" of, say, 10. Then return to Guide and click on the comet; if it is (for example) 4.5 magnitudes brighter than you would expect (either from observation or a provided ephemeris), then return to editing the comet's data, and add 4.5 to your initial "guess" for the absolute magnitude parameter.

The above process is admittedly quite barbaric. One alternative is to send e-mail or call any of the technical support numbers, listed on page 2, and ask for data for a particular comet.

Also, be aware that a particular set of elements is good for a limited time only (usually a few months around the epoch). Over time, gravitational effects of other planets will change the elements and, therefore, the object position. After a few months, if the object doesn't come too close to a planet, errors of a few arcseconds will accumulate; over a few years, the errors will grow to a few arcminutes.

## APPENDIX G: ASTRONOMICAL MAGNITUDES

The creator of the first star catalog, Hipparchos, was also the creator of the system used to measure the brightness of stars. He assigned a magnitude to each star: the brightest were magnitude 1 stars, those slightly fainter magnitude 2, and so on, down to magnitude 6. This was based strictly on looking at the star and guessing how bright it was.

The invention of the telescope revealed objects fainter than mag 6, so the scale was extended to higher numbers. It was eventually decided that five magnitudes should represent a change in brightness of a hundred-fold; that is, a mag 2 star should be 100 times brighter than a mag 7 star. This also means that each magnitude represents a 2.512 fold change in brightness. This is a somewhat unwieldy number, but we're stuck with it now.

This system means that one can measure fractions of a magnitude (Polaris, for example, is a mag 2.02 star) and that really bright objects can have negative magnitudes (Sirius is mag -1.58, Venus can be as bright as mag -4.4, the Sun is magnitude -26). It is still true, however, that most humans cannot see an object fainter than mag 6, though this limit varies among humans.

## APPENDIX H: COPYRIGHT AND LIABILITY NOTICES

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## APPENDIX I: LIST OF PROGRAM-WIDE HOTKEYS

The following hotkeys can be used at any point in Guide. You can get this list by hitting the ? key.

Be aware that almost all of these hotkeys have corresponding menu options! Some people are "keyboard-oriented", and like having all functions just a keystroke away. And if you find that you need to enter a few dozen ecliptic coordinates, it may be easier to hit Alt-Comma than to navigate the menus each time. But in most cases, you will find it easier to use the menu options than the hotkeys.

| Hotkey | Function |
|---|---|
| <enter> | Force a redraw |
| <space bar> | Stop a redraw |
| <esc> | Stop a redraw |
| <tab> | Toggle full-screen mode (DOS) |
| * | Zoom in one level |
| / | Zoom out one level |
| 1...9 | Zoom to levels 1-9 |
| 0 | Zoom to level 10 |
| Alt-1...9 | Zoom to levels 11-19 |
| Alt-0 | Set time to midnight UT |
| Cursor keys | Move mouse (DOS) |
| Num-5 | Center cursor (DOS) |
| Ctrl+cursor | Move mouse in small steps (DOS) |
| Ins | Left mouse button (DOS) |
| Del | Right mouse buttom (DOS) |
| + | Increase star sizes |
| - | Decrease star sizes |
| [ | Double animation step |
| ] | Halve animation step |
| ? | Show this list |
| , | Enter glossary (p. 4) |
| ; | Find an asteroid (p. 9) |
| = | Find a planet (p. 8) |
| > | Find a constellation (p. 10) |
| < | Toggle position readout (DOS) |
| % | Toggle coloring by spectral type |
| # | Star display menu (p. 22) |
| $ | Toggle outlining of stars (p. 23) |
| & | Enter an alt/az position (p 16) |
| @ | Toggle overlays menu (p. 41) |
| { | Load a mark file (p. 65) |
| } | Save a mark file (p. 66) |
| \| | Delete a mark file (p. 66) |
| ( | Toggle index marks on planet trails (p. 55) |
| ) | Select new level |
| \ | Find a variable star (p. 12) |
| ^ | Margins menu (Windows) |

| | |
|---|---|
| ~ | Switch to German |
| ' | Switch to Spanish |
| " | Switch to Italian |
| ! | Switch to French |
| i | Find IC object |
| m | Find Messier object |
| n | Find NGC object |
| F1 | Enter help system |
| F2 | Print (DOS) |
| F3 | Reset to current time |
| F4 | Scope control menu (p. 44) |
| F5 | User Object menu (p. 43) |
| F6 | Reset level size (p. 34) |
| F7 | Toggle previous view (DOS) |
| F8 | List all stars on screen (p. 57) |
| F9 | Go to colors menu (DOS) (p. 35) |
| F10 | Reset "printer stretch" (DOS) (p. 49) |
| F11 | Slew telescope to Guide posn (p. 45) |
| F12 | Slew Guide to telescope posn (p. 45) |
| Alt-A | Planet animation menu (p. 52) |
| Alt-B | Tables menu |
| Alt-C | Printer setup menu (DOS) (p. 47) |
| Alt-D | Display menu (DOS) (p. 20) |
| Alt-D | Data Shown (Windows) (p. 24) |
| Alt-E | Enter RA and declination (p 16) |
| Alt-F | File menu |
| Alt-G | Go To menu (p. 7) |
| Alt-H | Help menu (p. 4) |
| Alt-I | Inversion menu (p. 39) |
| Alt-K | Go to comet (p. 9) |
| Alt-L | "Flashlight" mode (DOS) (p. 33) |
| Alt-M | Video mode menu (DOS) (p. 4) |
| Alt-O | Overlays menu (p. 41) |
| Alt-P | Create PostScript chart (p. 50) |
| Alt-Q | Quick Info (p. 20) |
| Alt-R | Toggle between red screens and normal colors (p. 72) |
| Alt-S | Settings menu (p. 34) |
| Alt-T | Time menu (p. 50) |
| Alt-U | Find 'opposition' point (p. 16) |
| Alt-V | "Freeze" view (DOS) |
| Alt-W | Horizon dialog (p. 8) |
| Alt-X | Extras menu (p. 58) |
| Alt-Y | Display menu (Windows) (p. 20) |
| Alt-Z | Toggle north/zenith up (p. 40) |
| Alt-. (period) | Enter galactic lat/lon (p 16) |
| Alt-, (comma) | Enter ecliptic lat/lon (p 16) |
| Alt-[ | Coordinates menu (p 16) (DOS) |
| Alt-/ | Reset GRS longitude (p 36) |
| Alt-F1 | Toggle ecliptic (DOS) |
| Alt-F2 | Toggle horizon (DOS) |



| | |
|---|---|
| Alt-F3 | Toggle galactic equator (DOS) |
| Alt-F4 | Quit Guide |
| Alt-F5 | Language menu (DOS) (p. 35) |
| Alt-F6 | Extract RealSky/DSS image (p. 58) |
| Alt-F9 | Toggle user datasets (p. 63) |
| Alt-F11 | Clear all RealSky/DSS images (p. 58) |
| Shift-F1 | Set chart rotation (DOS) (p. 40) |
| Shift-F3 | Add to print queue (DOS) (p. 50) |
| Shift-F4 | Flush print queue (DOS) (p. 50) |
| Shift-F11 | Extract SA/A1.0 data (p. 60) |
| Ctrl-A | Toggle animation on/off (p. 53) |
| Ctrl-B | Find a Bayer or Flamsteed star (p. 10) |
| Ctrl-D | Data Shown (Windows) (p. 24) |
| Ctrl-E | Enter new default epoch (DOS) (p. 17) |
| Ctrl-F | Toggle camera frame (p. 62) |
| Ctrl-G | Toggle fixed levels (p. 27) |
| Ctrl-H | Select home planet (p. 38) |
| Ctrl-K | Add a new comet or asteroid (p. 81) |
| Ctrl-L | Toggle legend (p. 29) |
| Ctrl-N | Find NSV star (p. 12) |
| Ctrl-T | Measurement markings menu (p. 30) |
| Ctrl-U | Set limit for magnitude labels (DOS only) |
| Ctrl-V | Find a variable star (p. 12) |
| Ctrl-X | Enter longitude (p. 38) |
| Ctrl-Y | Enter latitude (p. 38) |
| Ctrl-Z | Enter altitude (p. 39) |
| Ctrl-F1 | Slew LX-200 to Guide posn (p. 45) |
| Ctrl-F2 | Slew Guide to LX-200 posn (p. 45) |
| Ctrl-F3 | Toggle Chart mode (p. 33) |
| Ctrl-F4 | Toggle cursor keys to pan (DOS) |
| Ctrl-F6 | Toggle Telrad (DOS) |
| Ctrl-F8 | Move CCD frame to cursor loc (p. 28) |
| Ctrl-F9 | Enter a date and time (p. 61) |
| Ctrl-F10 | RA/dec format dialog (p. 36) |
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| Ctrl-F12 | Extract objects from MPC file (p. 61) |

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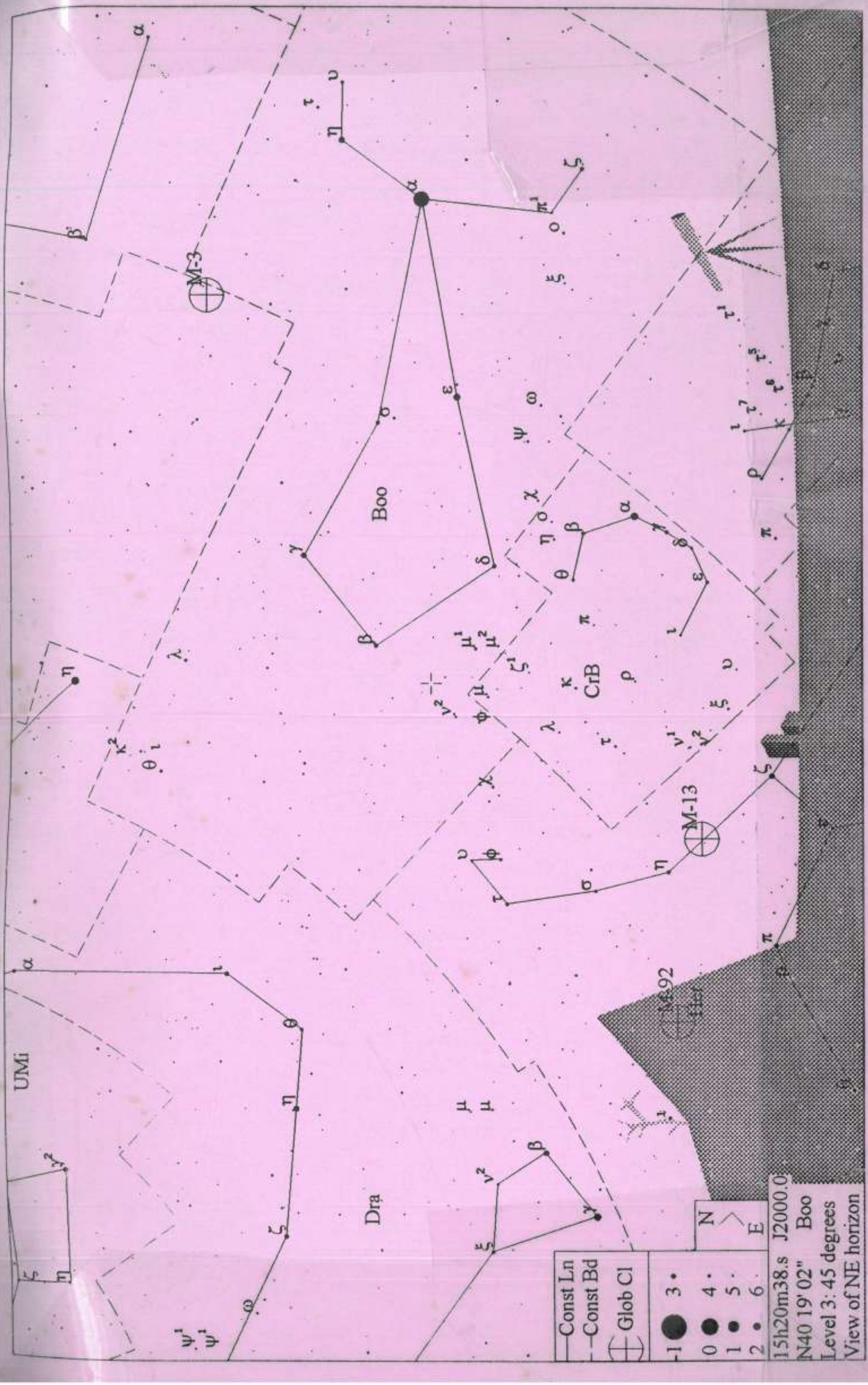
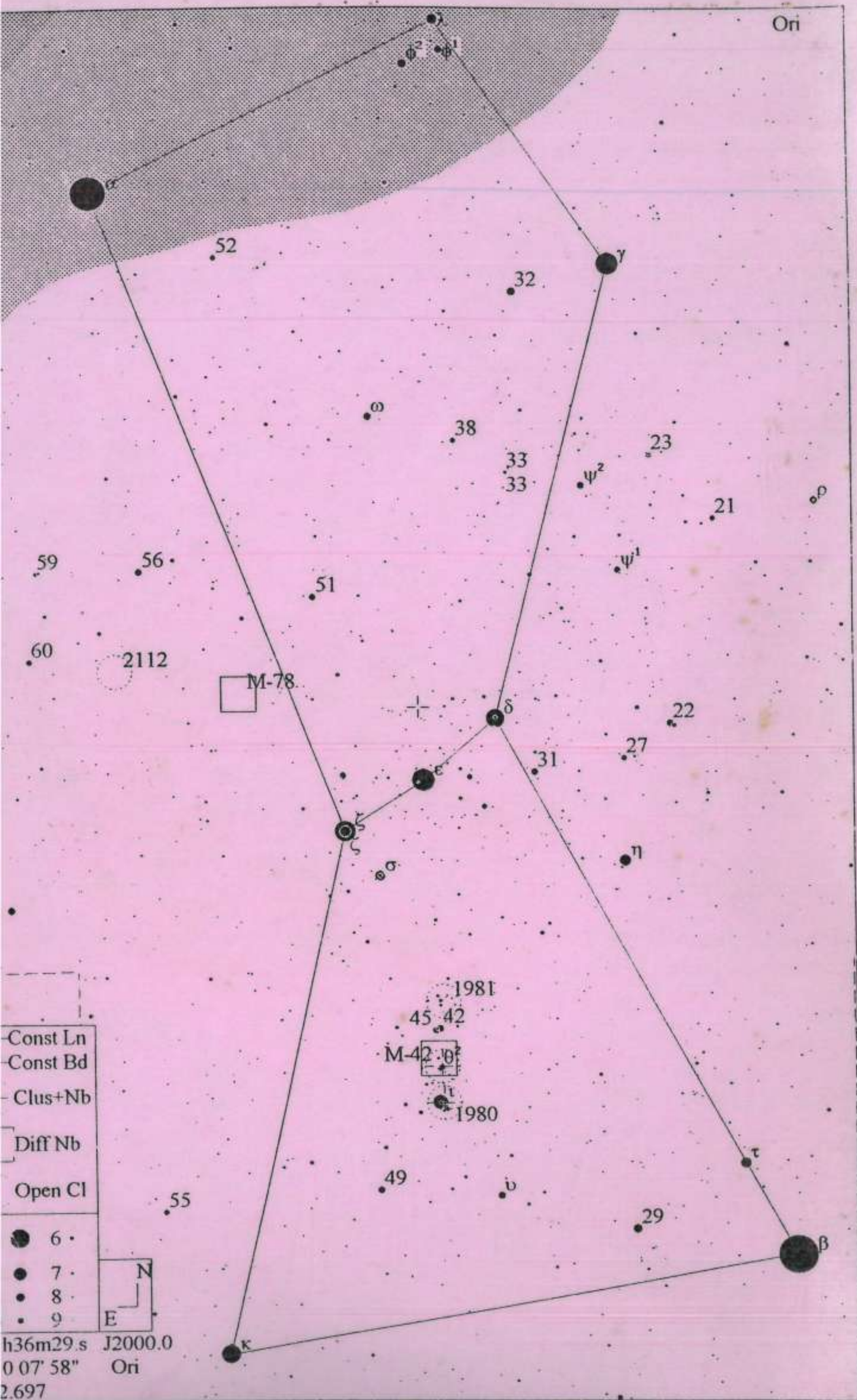

Boo
CrB
UMi
Dra
M-3
M-13
M-92
Const Ln
Const Bd
Glob Cl
15h20m38.s J2000.0
N40 19' 02" Boo
Level 3: 45 degrees
View of NE horizon



Ori
52
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38
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2112
M-78
22
27
31
1981
45 42
M-42
1980
49
55
29
Const Ln
Const Bd
Clus+Nb
Diff Nb
Open Cl
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0 07' 58"
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